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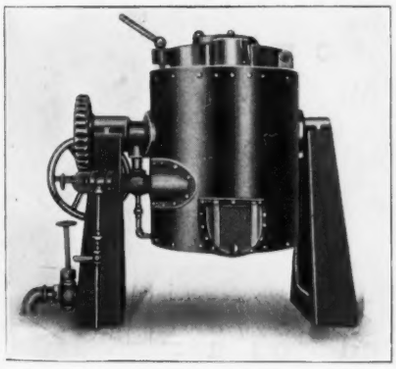

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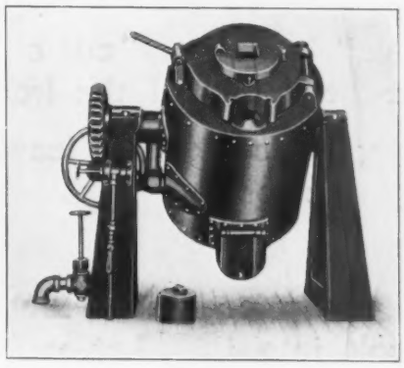

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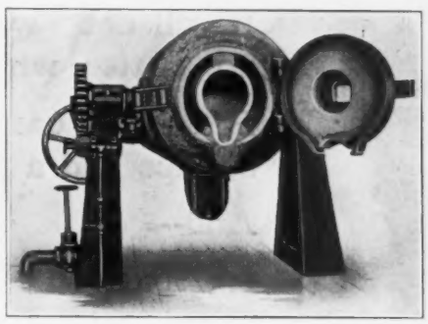

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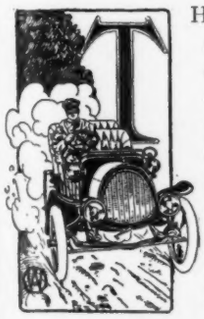
THE FOUNDRY

Vol. 35, No. 3 CLEVELAND, OHIO, NOVEMBER, 1909 Whole No. 207

GRAY IRON CASTINGS FOR AUTOMOBILES

Methods pursued in their manufacture in a foundry making a specialty of this line of work



THE growth of the automobile industry, during the last decade, is without parallel in the history of the country's industrial development. The investment in motor car manufacturing plants is enormous in its total, but despite this fact new capital finds this an inviting field and new companies are being organized almost daily. Concurrent with the growth of this business, there has been a wonderful development of allied industries, notably those engaged in the production of iron, steel and non-ferrous metal parts for motor cars. The foundry trade has been greatly benefited, and many new plants have been and are being established, which make a specialty of this line of work. The production of gray iron castings for automobile engines is practically a new branch of the foundry trade, which has been developed by the motor car industry. The requirements are exacting and the intricate designs test the skill of the foundryman.

Noted for its high grade product, the builders of motor cars in Detroit—in the early days of the industry and where it has since reached its highest development—turned to the Leland & Faulconer foundry of that city for the production of their engine castings, and the subsequent expansion of this trade resulted in making this plant a specialty shop, en-

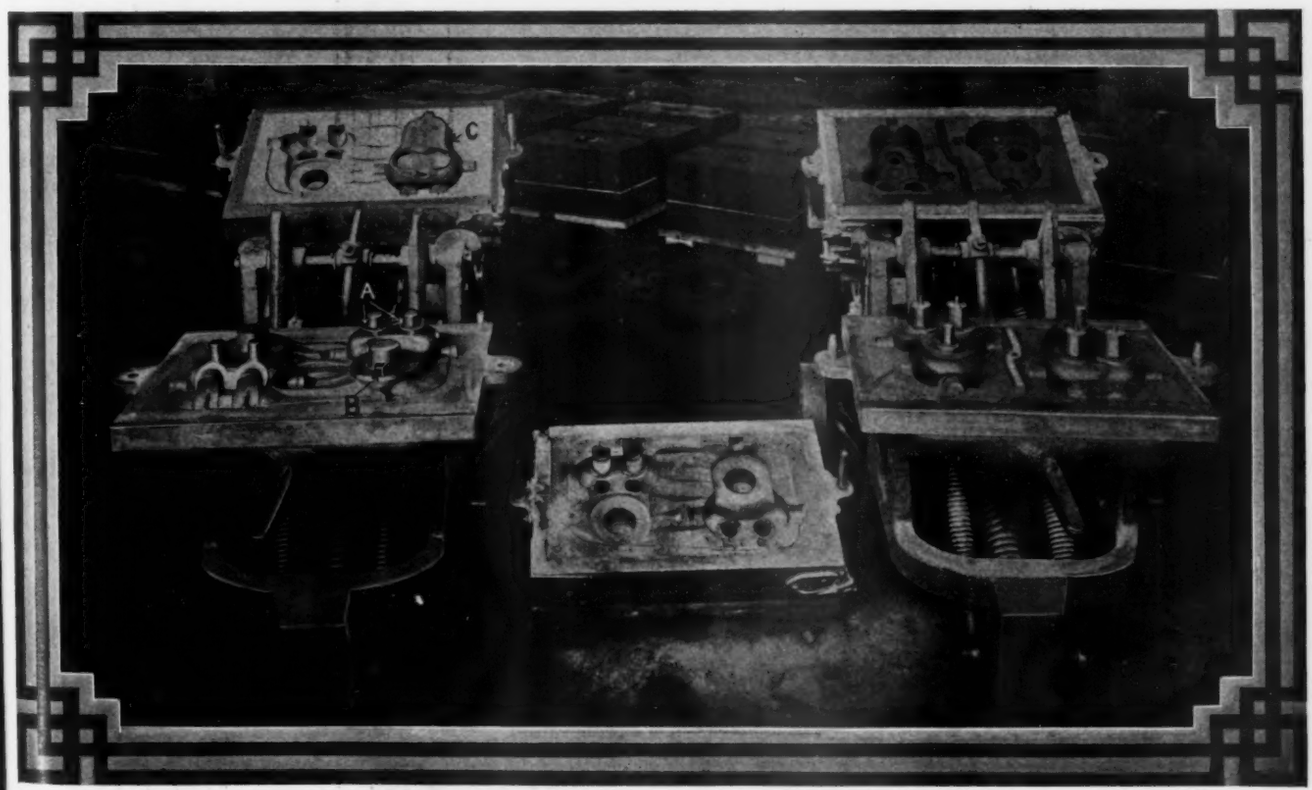
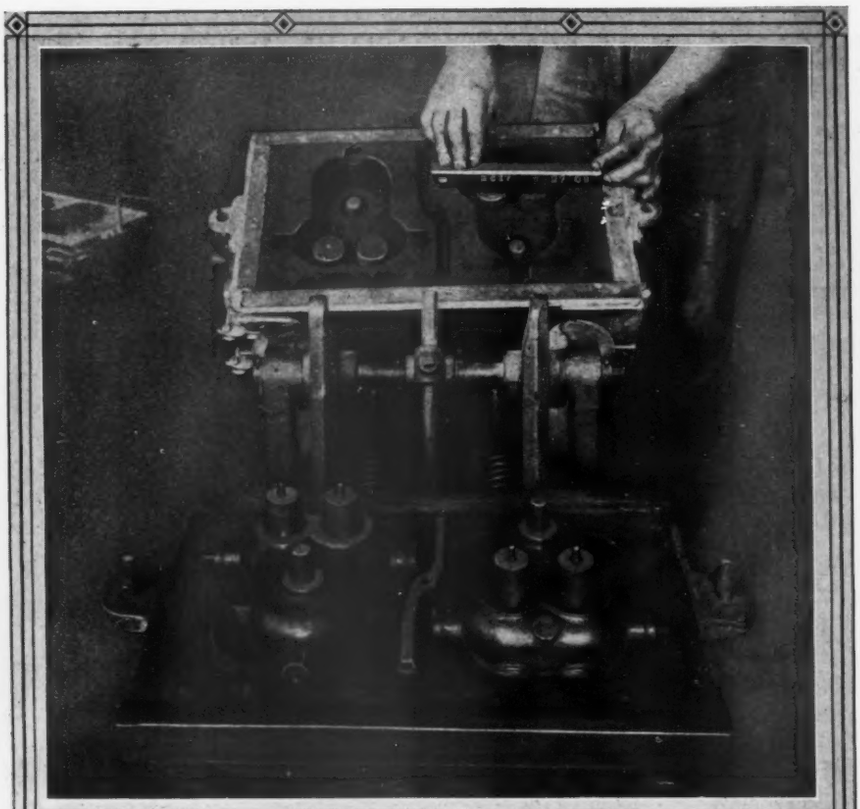


FIG. 1—VALVE CHAMBER PATTERNS MOUNTED ON A PAIR OF ROCK-OVER MOLDING MACHINES



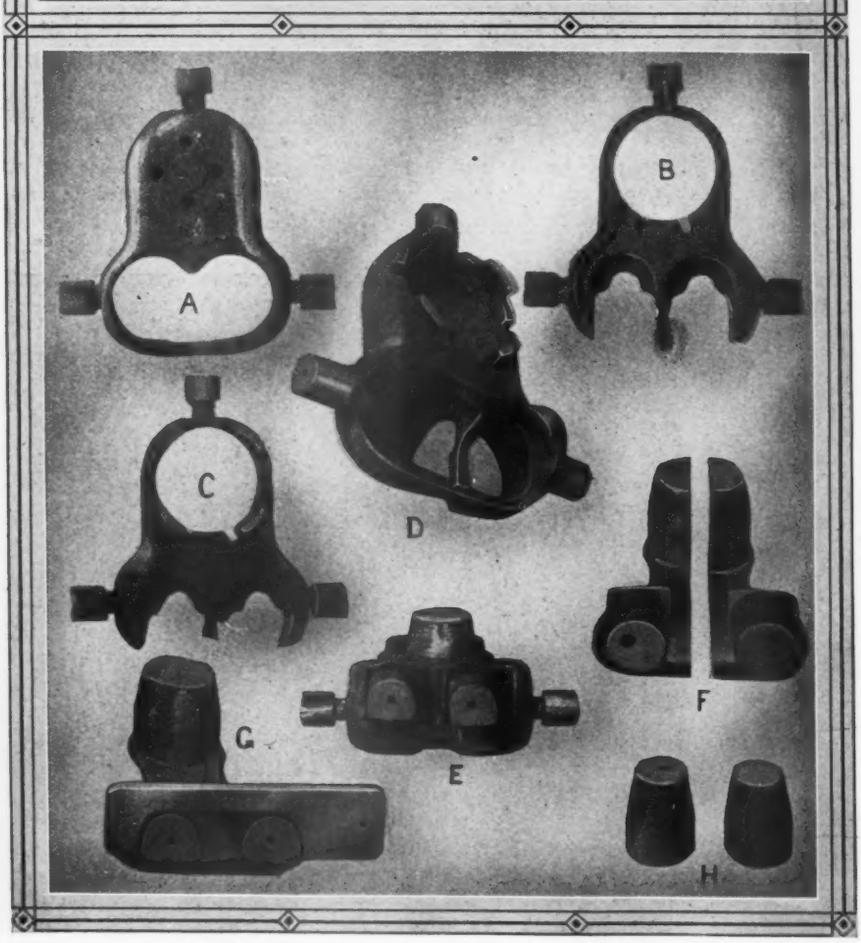


FIG. 2—MOLDER USING A FIXED GAGE TO PROPERLY LOCATE PARTS OF THE VALVE CHAMBER CORE

FIG. 3—THE VALVE CHAMBER CORE *E* AND ITS VARIOUS PARTS

gaged exclusively in this line of work. The foundry has since been taken over by the Cadillac Motor Car Co., and in addition to producing all of the castings required for the Cadillac cars, many orders are filled for other automobile builders.

Only to the adoption of scientific methods of foundry practice can the great success of this concern in the production of intricate automobile castings be attributed. Nothing is left to chance, and the minor operations receive the same consideration and supervision as those of more importance and which cannot readily be overlooked. The organization of the shop reflects the known skill of H. M. Leland as a foundryman, and the credit for its successful operation is given J. J. Wilson, superintendent.

Scientific Foundry Practice.

The statement that this, or any other foundry casting in sand, aims to work within 1/64 of an inch of the size of the pattern would not be credited, nor is it done in this case. Yet, if the castings show a continued variation in size, and when this reaches 1/32 of an inch, an investigation is immediately instituted with a view to correcting the difficulty, to check the tendency toward greater error. The core boxes and patterns are all gaged to within 1/64 of an inch, and any variation from this is not permitted. Fixed gages are freely used in the core department, especially on cores made in numerous parts that must be pasted together, while in the foundry these fixed gages and templates are used to insure the accurate placing of the cores. One department, therefore, has a constant check on the other, and if a core does not fit properly, but is found to be of the proper dimensions, it undoubtedly indicates that some correction must be made in the pattern.

Mixing and Melting.

The mixing and melting of the metal receives the same care and attention as the molding and coremaking operations. The mixtures are made by analysis, and the physical properties of every heat are tested. As the castings, with few exceptions, exceed 3/16 of an inch in section, the metal is run very hot, thereby insuring sharp definition and close grain. With the exception of the piston ring metal, which is melted in a separate furnace, all of the iron is tapped from one cupola. Two mixtures, and frequently three, are charged, the harder metal for the pistons and cylinders being melted first, followed by the

softer mixture. The metal for flywheels is tapped after the requirements of the piston and cylinder floors have been taken care of, and also includes the first melt of the soft iron.

The analysis of the iron used for cylinders and pistons follows:

	Per cent.
Silicon	1.6
Phosphorus	0.50
Manganese	0 70
Sulphur	0.085 to 0.09
Combined carbon	0.6

The silicon and phosphorus contents are varied according to the thickness of the metal in the castings.

Valve Chamber Casting.

The valve chamber of the Cadillac engine is an exceedingly intricate casting, being water-jacketed throughout, while the metal thickness is only 3 16 inch. Two views of this casting are shown at *K* and *L*, Fig. 24, and the method of molding the same on Pridmore rock-over machines is illustrated in Fig. 1. These machines are operated in pairs, the one producing the drags being shown at the left, and the cope machine at the right, while between the two is illustrated the drag half of a valve chamber mold before the cores have been set. The patterns are mounted two on a plate and three chills are carried in the drag, two on the valve stem openings at *A*, on account of the increased metal thickness in this part of the casting, and the third at *B* where there is an internal boss.

Valve Chamber Core.

The core is shown in position in the drag half of the mold at *C*, while the various parts in which the core is divided are illustrated in Fig. 3. The water-jacket core is in two halves, *A* and *C*, and *B*, which is the inside half of *C*, clearly illustrates the method of venting. The two halves, held together with wire clips for the purpose of mudding-up the joints to insure an absolutely smooth surface before pasting them together, are shown at *D*. The two halves of the body core, *F* and *G*, are pasted together, a gage being used to insure an accurate fit. If the two halves fail to come together within 1/64 inch, the core is considered imperfect. The body core floats in the water-jacket core and is inserted in the latter before it is pasted together. The assembled core is shown at *E*. The body core prints at three points in the drag as illustrated in Fig. 1, while the water-jacket core likewise has three prints, one on top and two at the sides. Cores *H*, which form the openings for the spark plug caps, were formerly

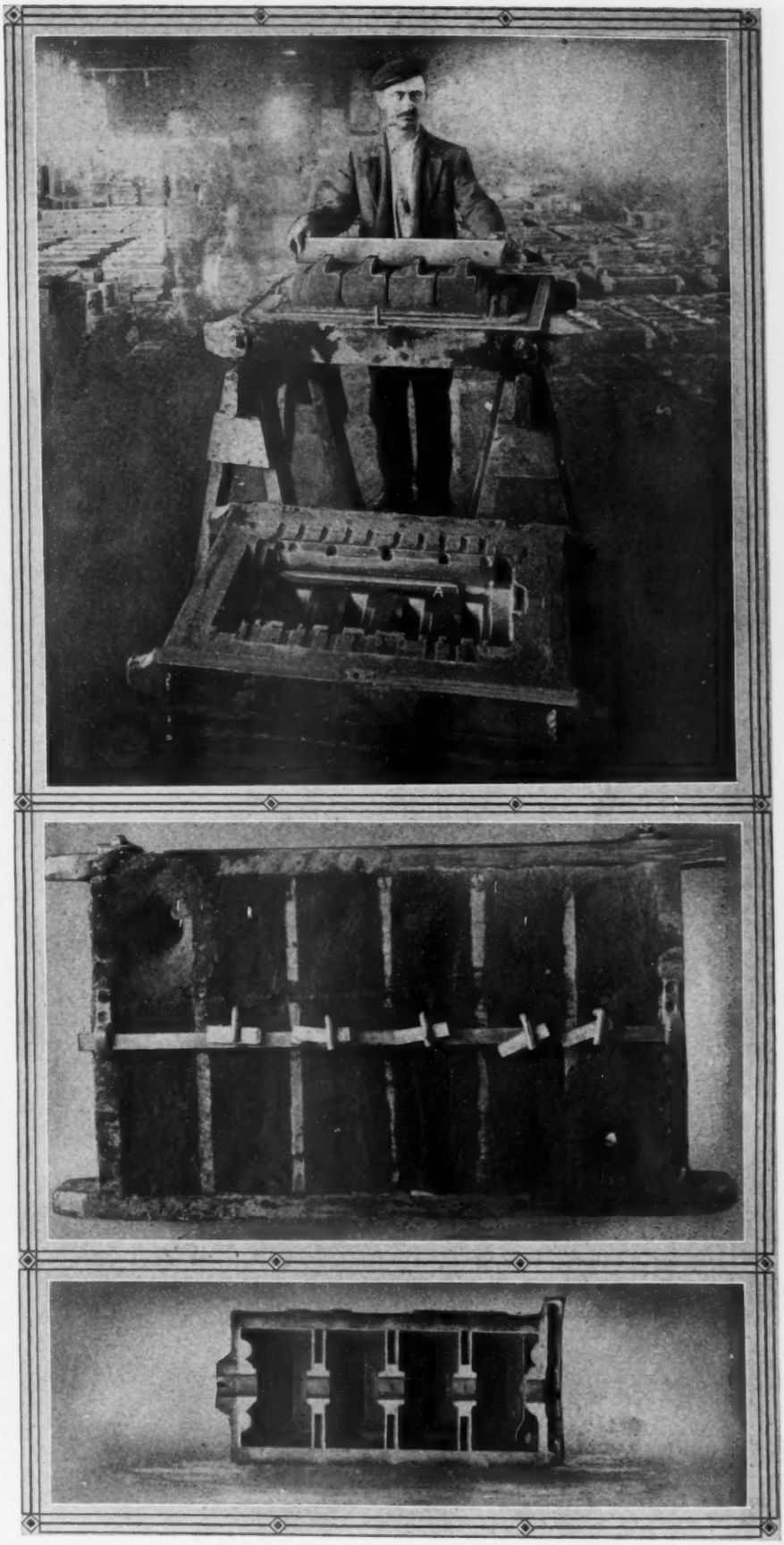


FIG. 4—SETTING THE FOUR MAIN BODY CORES IN THE COPE OF THE LOWER HALF OF A CRANK CASE MOLD BY THE USE OF A TEMPLATE.

FIG. 5—TOP VIEW OF COPE FLASK SHOWING HOW THE FOUR MAIN BODY CORES ARE HELD IN THE COPE HALF OF THE MOLD

FIG. 6—LOWER HALF OF CRANK CASE CASTING

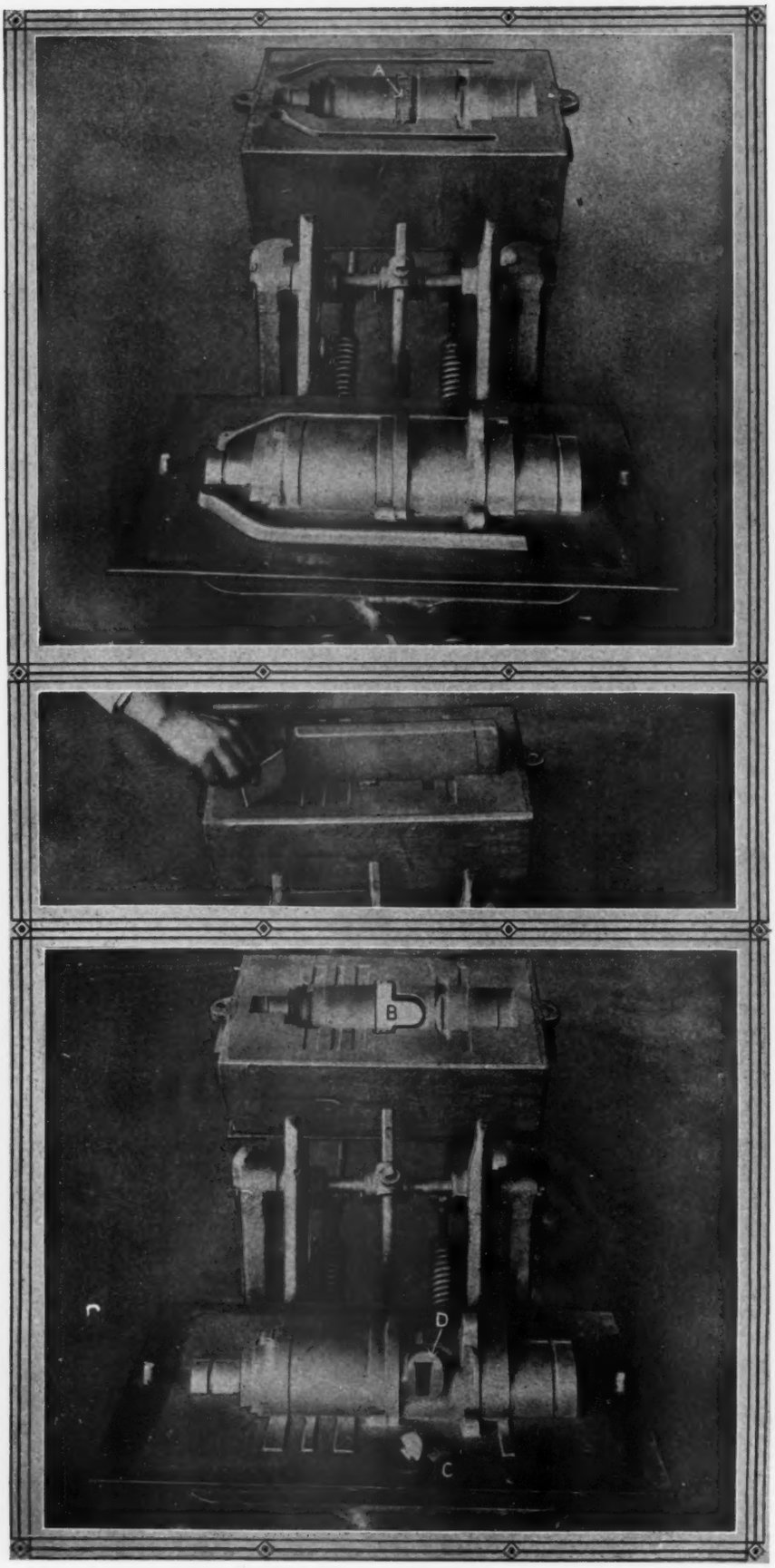


FIG. 7—COPE HALF OF CYLINDER MOLD MADE ON A ROCK-OVER MOLDING MACHINE

FIG. 8—USING A FIXED GAGE TO PROPERLY LOCATE THE MAIN BODY CORE IN THE DRAG HALF OF THE CYLINDER MOLD

FIG. 9—DRAG HALF OF CYLINDER MOLD ON A ROCK-OVER MACHINE

made parts of the body core, but they can be more easily handled separately and are, therefore, set in the cope before the valve chamber core is placed in position. As they contact with the body core, they must be set accurately to avoid crushing either the water-jacket or body cores, and when placing them in position in the cope a gage is used which has a bearing on the parting on either side. If the core is 1/64 inch too low or too high, it must be either reset or discarded entirely and replaced by another core.

Lower Half of Crank Case.

While the crank cases for the engines of many motor cars are made of cast aluminum, gray iron is employed successfully for this purpose by this concern. The weight of the iron casting is not more than 25 per cent greater than a similar aluminum section, having a greater metal thickness, and in addition, the gray iron casting gives increased strength. The crank case is cast in halves, and the method of molding, as well as the setting of cores in the lower half, which is known as the oil pan, is illustrated in Fig. 4. The drag is resting against the horses in the lower part of this view, the cores already having been placed in this section of the mold. The long core, *A*, forms the return passage for the oil, conveying it to the first compartment, while the V-shaped openings between the four large cores in the cope carry the oil to the main shaft bearing.

Template Used for Setting Cores.

To obviate the use of chaplets, the large cores are hung in the cope, and when setting them in place a template is used, as shown, to insure their proper location in the mold. No less than 12 cores are set in the cope, the smaller ones being held in position by the four large cores. When these large cores are made, wire eyes are rammed in the sand on the cope side through which hooks are passed, that are wedged against the bar extending the length of the flask, as shown in Fig. 5. This bar is held in position by two brackets on either end of the cope flask. By this method these cores are firmly held in position and all danger of a shift is prevented. The lower half of the crank case casting is shown in Fig. 6, the metal thickness throughout being only 3/16 inch.

Although the Cadillac engine is of the four-cylinder type, the cylinders are cast individually and are provided

with a copper water-jacket, which simplifies the molding operation considerably. Although hand rammed for many years, the cylinder patterns recently have been mounted on Pridmore rock-over molding machines and are successfully produced by machine operators, with an increase in the output of 50 per cent, as compared with hand methods. The machines are operated in pairs, one producing the copes and the other the drags. The cylinders have a 4¼-inch bore, 4½-inch stroke and the metal thickness is 7/32 inch. The cope machine, showing the pattern plate and cope half of the mold, is illustrated in Fig. 7. The core *A*, which produces the ring for seating the copper water-jacket, is in position and is nailed at three points to prevent shifting. The drag machine, with pattern plate and mold, is shown in Fig. 9. The drag ring core is in position at *B* and forms the water inlet to the copper water-jacket. Loose piece *C* on the pattern plate fits into the pattern at *D*, and is separately withdrawn from the sand, remaining in the mold after the body of the pattern has been lifted away.

Setting the Main Body Core.

The main body core of the cylinder is set in the drag and is located with a fixed gage, as illustrated in Fig. 8. This gage secures its bearing on the parting, while the other end rests against one of the projections on the main body core. The use of a gage is absolutely necessary when setting this core to insure the proper location of the water passage of the cylinder with that of the valve chamber. The cylinder casting is shown at *J*, Fig. 24.

Muffler Heads.

Both inlet and outlet muffler heads are mounted on one pattern plate, the drag halves of the molds being made on one machine, Fig. 10, and the copes on another, Fig. 12. When molded by hand considerable difficulty was experienced in making these castings, but since the patterns have been mounted on machines, the losses have been materially reduced. The inlet muffler head patterns and molds are shown at the left in Figs. 10 and 12, and the outlet head at the right. The cope machine is illustrated in Fig. 12, and the hubs of these muffler heads, inasmuch as they cannot be drawn out of the sand with the main body of the pattern, are in two sections and dovetail onto the main pattern body. These loose pieces are shown on the pattern plate in Fig. 12,

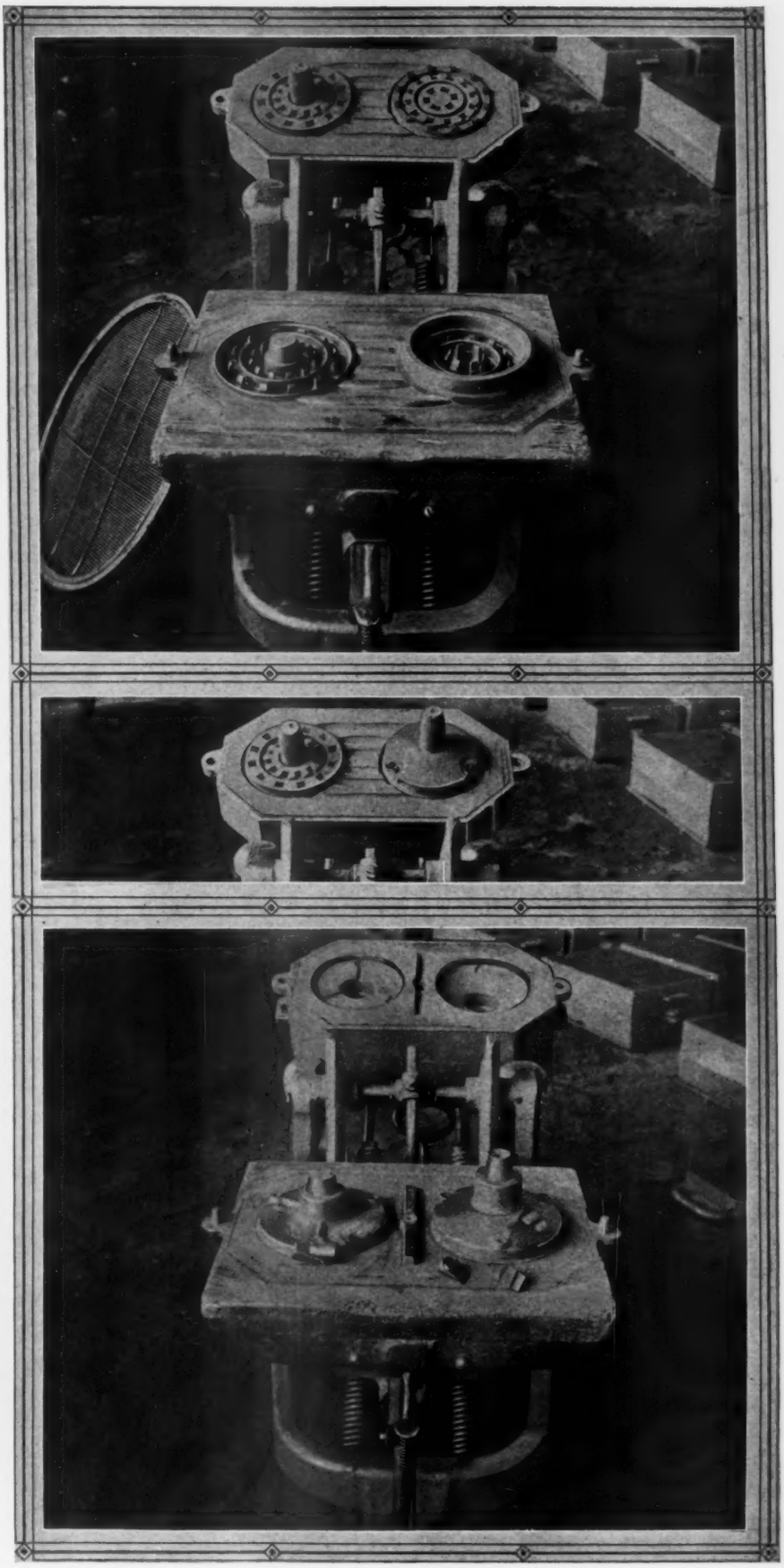


FIG. 10—DRAG HALF OF INLET AND OUTLET MUFFLER HEAD MOLDS MADE ON A ROCK-OVER MOLDING MACHINE

FIG. 11—DRAG OF MUFFLER HEADS WITH CORES IN POSITION

FIG. 12—COPE OF MUFFLER HEADS MADE ON A ROCK-OVER MOLDING MACHINE

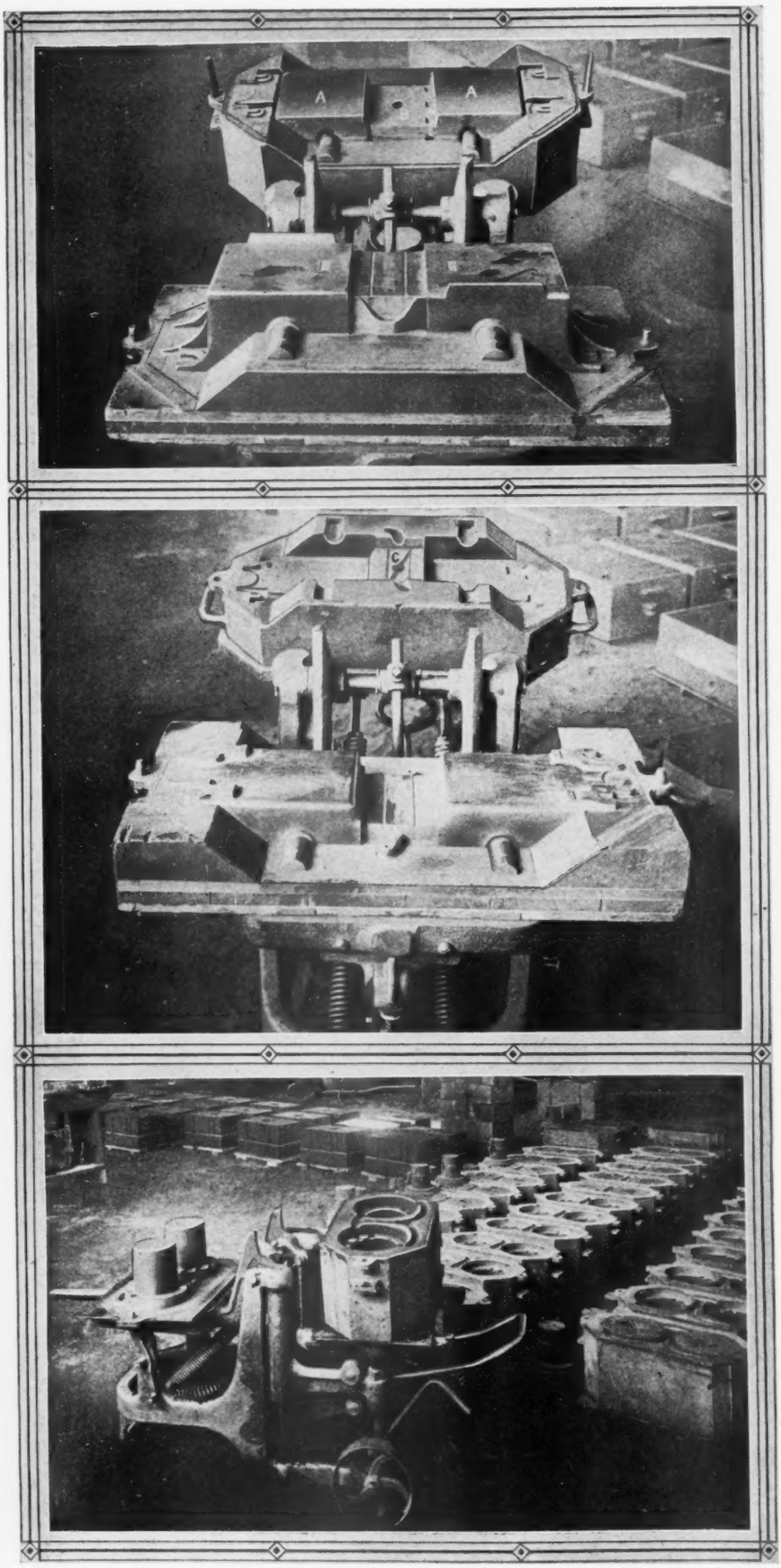


FIG. 13—DRAG HALF OF LUBRICATOR BODIES MADE TWO IN A MOLD, SHOWING THE LARGE FLAT CORE IN POSITION

FIG. 14—COPE HALF OF LUBRICATOR BODY MOLD

FIG. 15—ROCK-OVER MACHINE FOR MOLDING DRAG HALVES OF PISTON MOLDS

and are lifted out of the sand separately after the pattern has been withdrawn. The cone-shaped core of the outlet head is in position in the drag in Fig. 11, and an inside view of the outlet muffler head casting is shown at *I*, Fig. 24.

Lubricator Body Castings.

Lubricator bodies, mounted two on a pattern plate on a rock-over molding machine, are shown in Figs. 13 and 14. These castings are open at one end, as shown at *A*, Fig. 24, and the core for both molds is made in one section, as illustrated at *A*, Fig. 13. This core is supported by four prints and also has a bearing in the center. Great care must be exercised in setting this core in the mold as the metal thickness in the casting is only ⅛ inch. Owing to its length, the core is well rodded throughout, and to insure a uniform metal thickness from day to day, the patterns are numbered 1 and 2 respectively, the castings being similarly marked. If either one of the castings is thin on one side and proportionately heavier on the other, it undoubtedly indicates that the core box has become worn and the number on the castings gives a clue to the box which is causing the trouble, so that the difficulty can be remedied before a large amount of scrap is accumulated. This large core is vented through the four prints, which have an outlet in the center of the flat core between the two body cores at *B*, Fig. 13. From this point the gases are carried up through the cope through the opening in the middle bar of the flask at *C*, Fig. 14. All of the flasks for these lubricator body molds are constructed in this way, a permanent vent being provided in the center bar.

Two machines are used for making these molds, the drag machine with the drag mold being illustrated in Fig. 13, and the cope in Fig. 14. Owing to the thin section of the castings, the metal is dashed into the molds with considerable head. These lubricator bodies also carry brackets on one end, slightly heavier than the remainder of the casting, but no chills are used as no difficulties from shrinkage spots have yet been experienced, owing to the great care exercised in pouring the metal.

Machine-Molded Pistons.

A floor of piston molds, with the rock-over machine on which the drags are made, is shown in Fig. 15. These castings are 4¾ inches in diameter, 5 inches high, and the metal thickness is uniformly 1¼ inches. The

patterns are mounted two on a plate, and the cores are easily set, the gates being used as guides. The copes are in the nature of a covering for the drags and do not carry any portion of the molds. They are made on cope stands, no machines being used.

Use of Match Plates.

A Modern molding machine on which metal plates are used, made by the Arcade Mfg. Co., Freeport, Ill., is shown in Fig. 17. Both cope and drag are made in one operation. The plates mounted on this machine contain the patterns for four commutator boxes, which have a metal thickness of 3/16-inch. A large number of white metal pattern plates for miscellaneous castings are used on this machine. The method of casting these plates is as economical as it is novel and will be referred to later.

Molding the Fly-Wheel.

The fly-wheel for the Cadillac engine is molded on a rock-over molding machine, Fig. 16. The casting weighs approximately 80 pounds, and both cope and drag are molded on one machine, a floor of drags being made up first, after which the copes are molded, the only change necessary in the pattern being in the hub. The changes from cope to drag are effected by the use of interchangeable bosses made of brass, the cope boss being shown in position on the pattern at *A*, and the one for the drag at *B*. These are located and held in their proper position by a small pin which engages a slot in the pattern. Two drags are shown on the floor at the side of the machine with the hub cores in position, while the cope half of the mold is shown on the machine. The runner core, containing six gates, is in place, and by the use of these cores the metal is skimmed and clean castings are insured.

Piston Rings.

The gray iron castings from which the piston rings are cut are made in another department of the foundry especially devoted to this line of work. The utmost care is exercised in the production of these castings to insure the proper elasticity and wearing quality of the rings. Not only are the molds carefully made, but the metal is melted in a separate cupola, lined to 24 inches, originally installed for experimental purposes. Physical tests of this metal are made daily, and all mixtures are carefully analyzed to insure absolute uniformity. As a result of the care exercised in their produc-

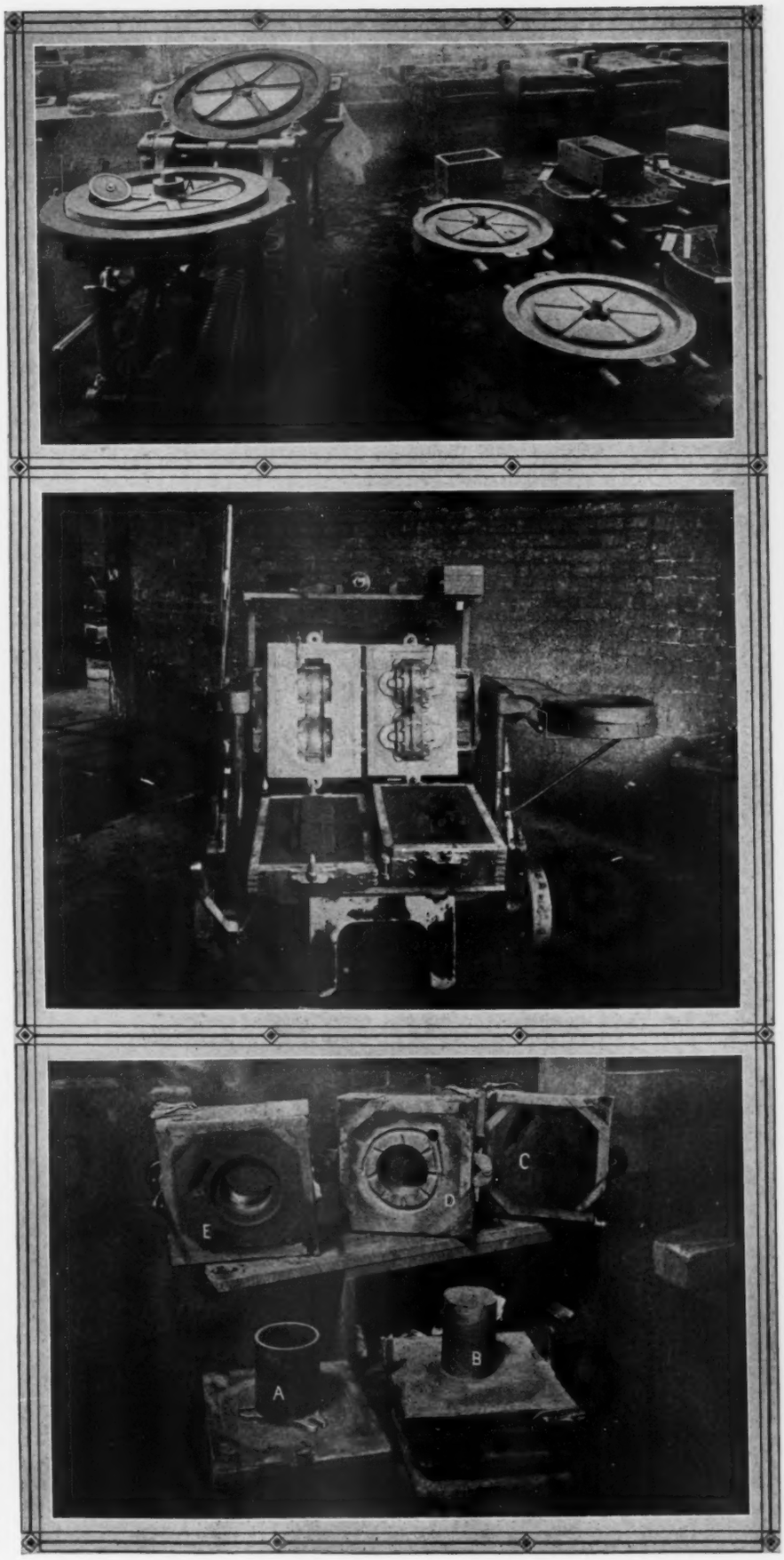


FIG. 16—ROCK-OVER MACHINE ON WHICH COPES AND DRAGS OF FLY-WHEEL MOLDS ARE MADE

FIG. 17—FOUR COMMUTATOR BOXES MADE IN ONE MOLD BY THE USE OF WHITE METAL PLATES, ON THE ARCADE MACHINE

FIG. 18—COPE, CHEEK AND DRAG OF PISTON RING CASTING MOLD

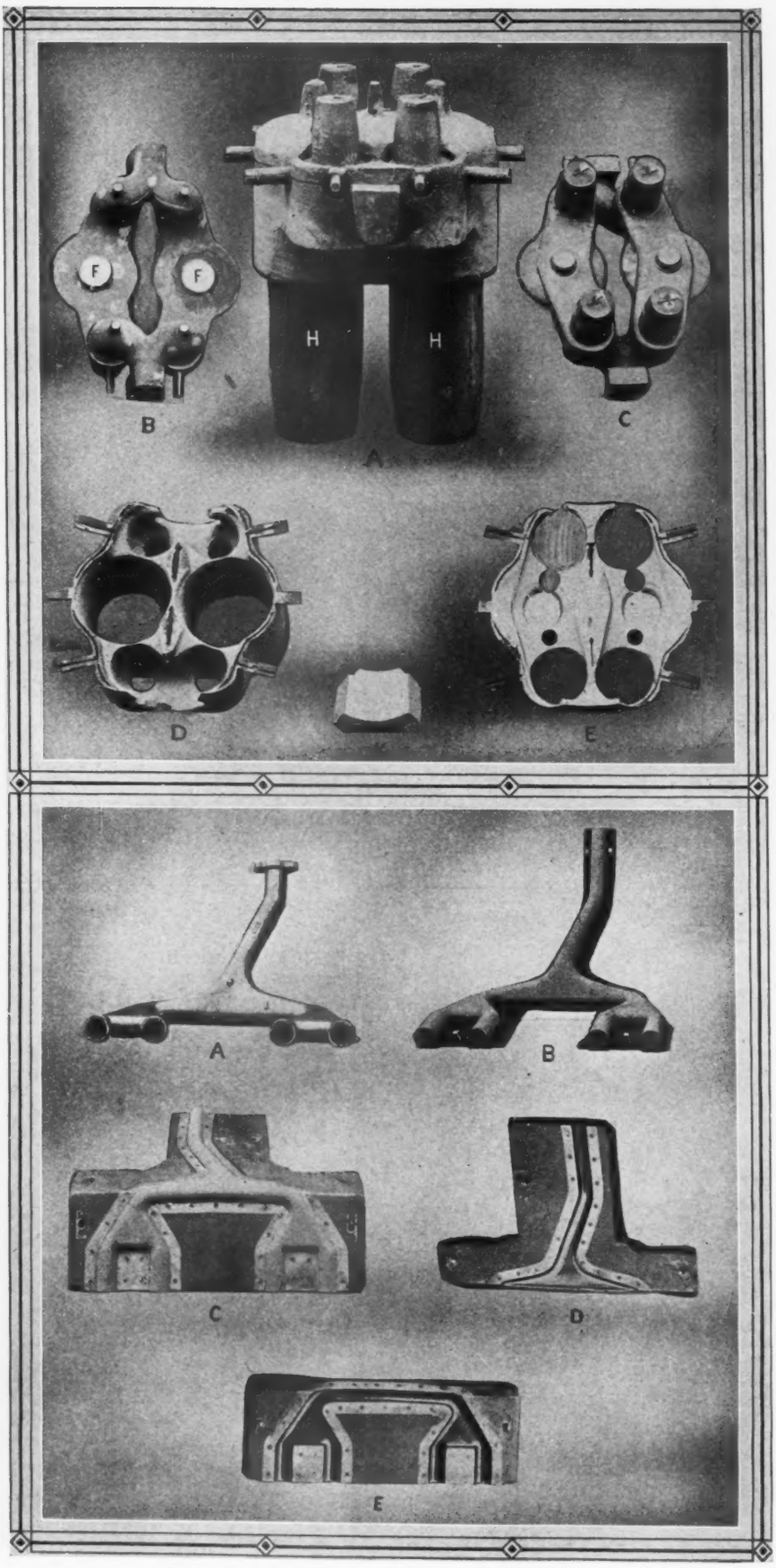


FIG. 19—TWIN-CYLINDER CORE AND THE VARIOUS PARTS FROM WHICH IT IS ASSEMBLED

FIG. 20—INTAKE PIPE CORE *B* AND THE PARTS OF THE CORE BOX *C*, *D* AND *E*, IN WHICH THIS CORE IS MADE

tion, the piston rings made by this foundry have a world-wide reputation, and are used extensively by builders of gas engines. The daily melt of this one grade of iron averages from 3,000 to 4,000 pounds, and is far in excess of the Cadillac Motor Car Co.'s requirements. In addition to the physical tests of the iron from each heat, the piston rings are given a fatigue test for elasticity by suspending a weight from one end of the cut ring. If the ring does not practically close when this weight is removed after a period of 24 hours, the entire lot of piston rings is rejected.

Analysis of Piston Ring Metal.

The analysis of the metal used in these rings follows:

	Per cent.
Silicon	1.6
Phosphorus	1.2
Manganese	0.4
Sulphur	0.09
Combined carbon	0.60

It will be noted that the phosphorus is unusually high, insuring fluid metal and a close grain, while the silicon content is sufficiently high for easy machining. Both manganese and carbon are low.

Double Skim Gates.

The method of molding these piston ring sections is illustrated in Fig. 18, *A* being the pattern, *B* the drag, *C* the cope, *D* the lower half of the cheek, and *E* is the upper half of the cheek, over which the cope is closed. The molds are hand-rammed, and to insure clean metal in the castings, double skim gates are used. In the cope *C*, a skim gate is shown and the metal flows through this gate into the skim gate in the cheek *E* before flowing through the runner into the lower part of the cheek *D*, where it is distributed by eight gates. This gating arrangement insures absolutely clean castings, and is only one of the minor details that has made possible the production of the high-grade piston ring metal made in this shop.

Twin-Cylinder Core.

The production of cores for automobile castings, owing to their intricate forms, involves difficulties not generally experienced in gray iron shops. The designer of motor cars rarely considers the foundryman as a factor of importance in economical manufacture, and as a result many weird sections are received in the foundry that test the ingenuity of both the molder and coremaker.

An exceedingly intricate core for a twin-cylinder casting is shown assembled at *A*, Fig. 19. It consists of

a water jacket core, intake and outlet cores, as well as two large, main body cores. The inlet and outlet core, reverse sides of which are illustrated at *B* and *C*, is made in four sections, which are gaged when pasted together. This core is enclosed in the water-jacket core, the two halves of which, *D* and *E*, are pasted together. The method of venting the water-jacket core is clearly shown, the gases being carried off through the prints. The inlet and outlet core secures its bearing at *F F*, where it rests on the two main body cores, *H H*. The core *K* is made in halves and is inserted in the mold between the body cores. The twin-cylinder casting, for which this core is used, is shown at *G*, Fig. 24.

Intake Pipe Core.

Although simple in design, the production of the core for the intake pipe *A*, Fig 20, involves many difficulties. The core box is made in three parts, *C*, *D* and *E*. One-half of the core is first rammed in section *C*, and the other parts are subsequently rammed in *D* and *E*. After liberally venting with wax wires, *D* and *E* are closed over *C*, and after rapping, these two halves are removed and the core pan *B* on with the core is shown in position for drying, is set over the core in the box *C*. The four lugs are provided for locating the pan and are of sufficient height to prevent crushing the core. Owing to the peculiar shape of these cores, they are dried on pans to prevent distortion. The pans are made of cast iron and despite repeated heating, hold their shape for a considerable period. The three sections of the core box are made of wood, but the pattern for the core is brass.

Engine Base Core.

The engine base core shown at *C*, Fig. 21, necessitates the use of no less than 21 loose pieces in the core box *A*. The box dissembled, with the loose pieces in the foreground, is illustrated at *B*. While the body is of wood construction the loose pieces are made of brass, white metal and aluminum, and the box itself is reinforced with brass and steel strips. The oil duct cores are separately made and are pasted onto the main body core. The camshaft opening core is in two sections and is forced out against the mold when closing to insure cutting through. At *C* the drag side of the core is uppermost, while the cope side is grooved for vents. This core is 29½ inches long, 10 inches wide and 8½ inches high. The metal thickness of the engine base casting, *D* and *E*, is 3/16-inch.

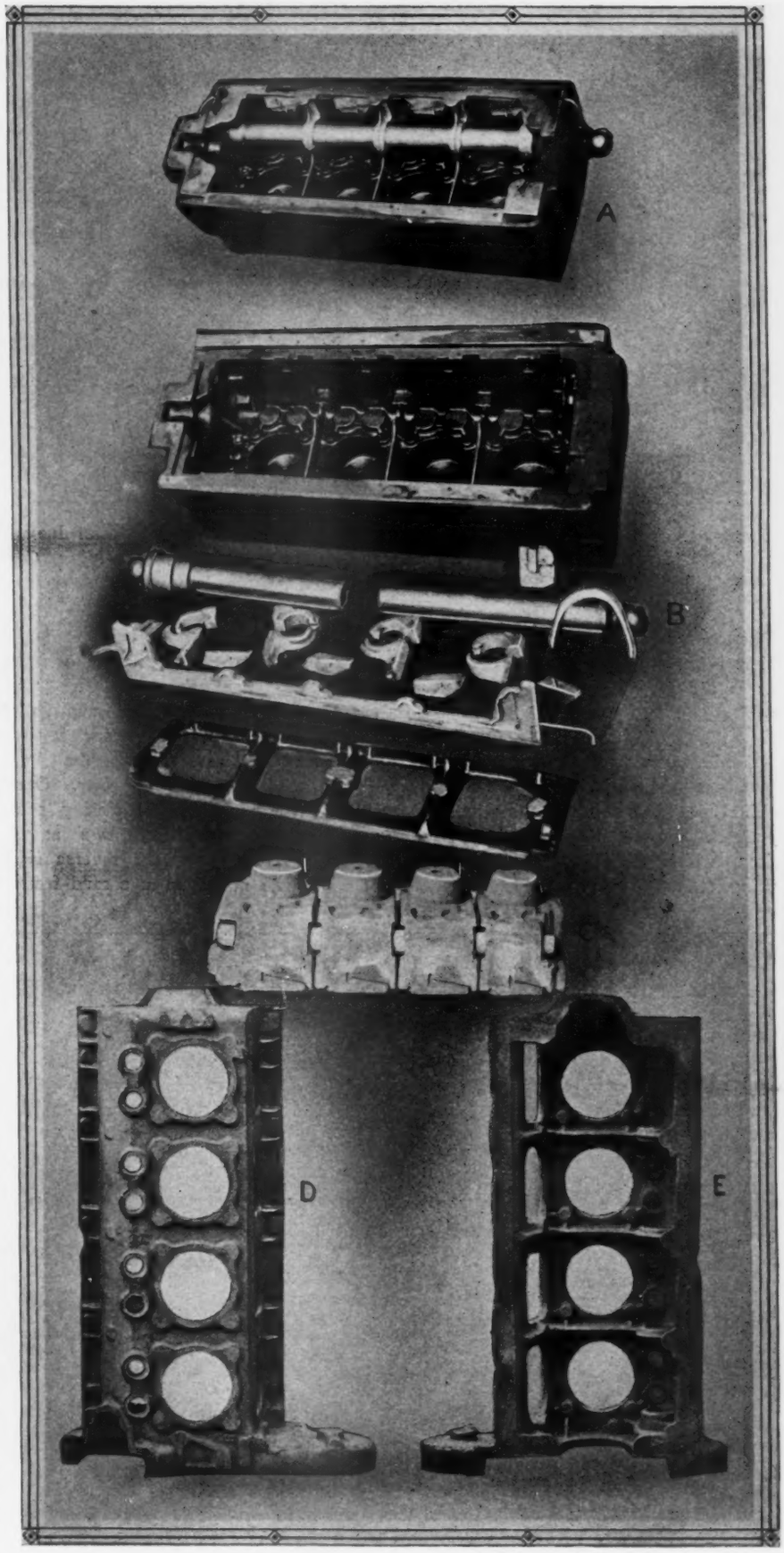


FIG. 21—THE ENGINE BASE CORE BOX WITH ALL LOOSE PARTS IN POSITION IS SHOWN AT *A*, AND THE BOX IS DISSEMBLED AT *B* WITH THE LOOSE PIECES IN THE FOREGROUND; *C* IS THE INTRICATE CORE MADE IN THIS BOX

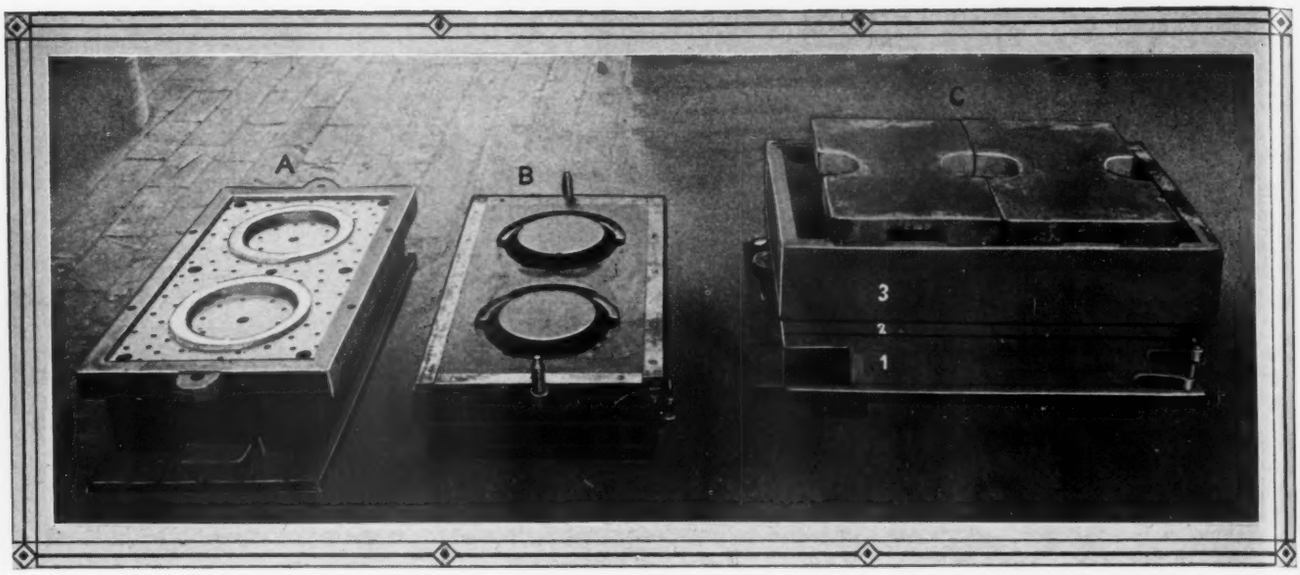


FIG. 22—METHOD OF CASTING WHITE METAL MATCH PLATES; *A* IS THE CAST IRON PLATE RESTING ON THE SAND FRAME; *B* IS THE MOLD FOR ONE OF THE PLATES, AND *C* SHOWS THE MOLD, CAST IRON PLATE AND SAND FRAME WEIGHTED, READY FOR THE METAL

The core mixture largely used in this shop is made with linseed oil as a binder in the proportions of 1 to 30.

White Metal Match Plates.

A simple method of producing white metal match plates for molding machine use, is illustrated in Fig. 22. The plate A is cast with a recess 5/16-inch deep, which obviates the necessity of using strips on the flask to raise the plate away from the mold to obtain the desired metal thickness of the pattern on the match plate. The mold is rammed in an ordinary snap flask, the cope side being used for casting the cope pattern plate, and the drag half is used for the drag plate. One-half of the mold, before closing over the cast iron plate, is shown at *B*, while *A* is the plate, the reverse side of which is rammed up in a sand frame through which the gates and risers are cut to prevent the white metal from flowing out at the back through the openings in the plate. The mold, closed and weighted ready for the metal, is shown at *C*. The snap flask containing one-half of the mold is shown at *1*, and the cast iron plate *2*, which will subsequently contain one-half of the pattern is interposed between the mold and the temporary sand frame *3*. To

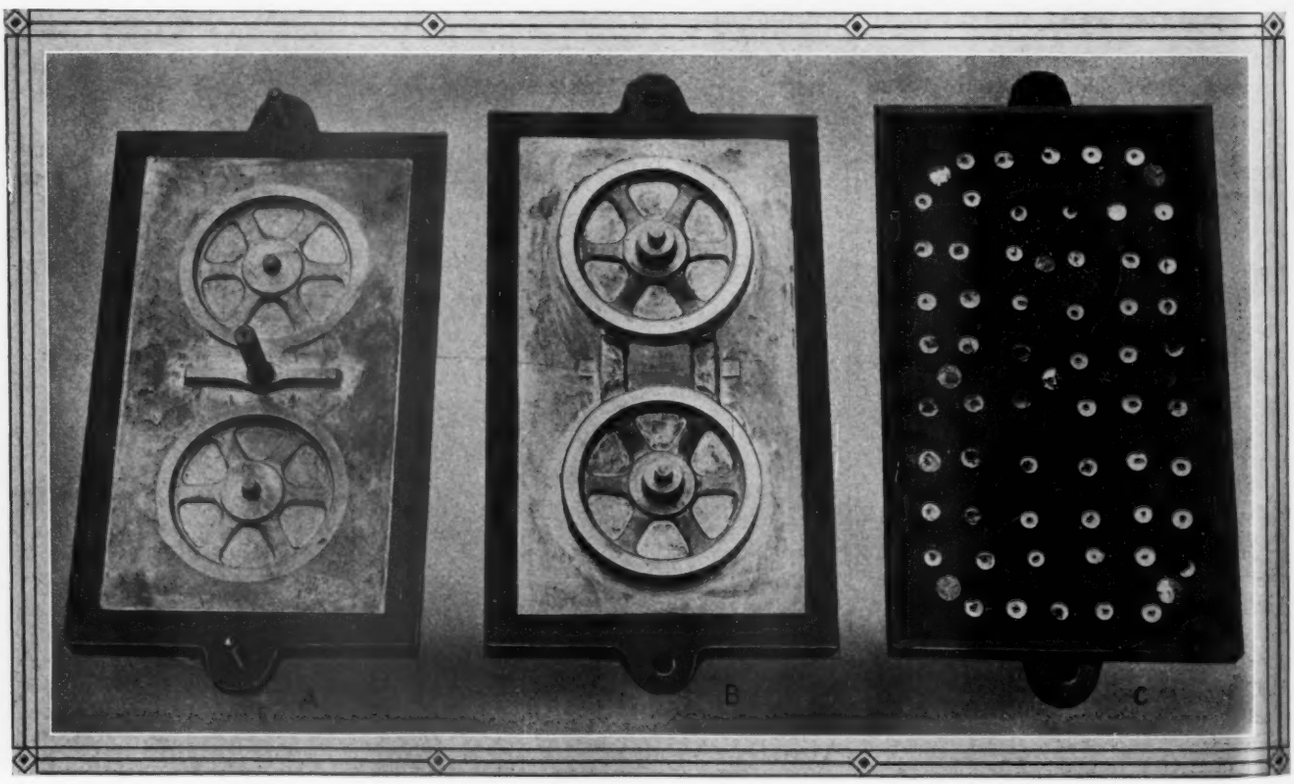


FIG. 23—COPE AND DRAG MATCH PLATES *A* AND *B*; *C* IS THE REVERSE SIDE OF THE CAST IRON MATCH PLATE SHOWING THE METHOD OF ANCHORING THE METAL

anchor the white metal, the cast iron plate is drilled with numerous openings reamed on the bottom side of the plate, as illustrated at *C*, Fig. 23, and *A* and *B* are the cope and drag plates of a small wheel made two in a mold. The white metal mixtures used for these match plates consist of tin 41 per cent, lead 41 per cent, antimony 16 per cent, and bismuth 2 per cent.

Miscellaneous Automobile Castings.

The following miscellaneous gray iron automobile castings made in this foundry are illustrated in Fig. 24: *A* shows the open end of a lubricator body, and *B* is the opposite end of this casting; *C* is a cut-out valve body together with its valve; *D* is an intricate water pump body casting; *E* is the transmission gear case for the Cadillac motor car; *F* is the exhaust pipe; *G* shows the side and top views of a water-jacketed twin-cylinder casting; *H* is the commutator bracket molded on the Arcade machine; *I* is a muffler head casting; *J* is the Cadillac engine cylinder; *K* is the top view of the valve chamber, and *L* is the side of this casting that is screwed to the cylinder, while *M* is the piston ring casting.

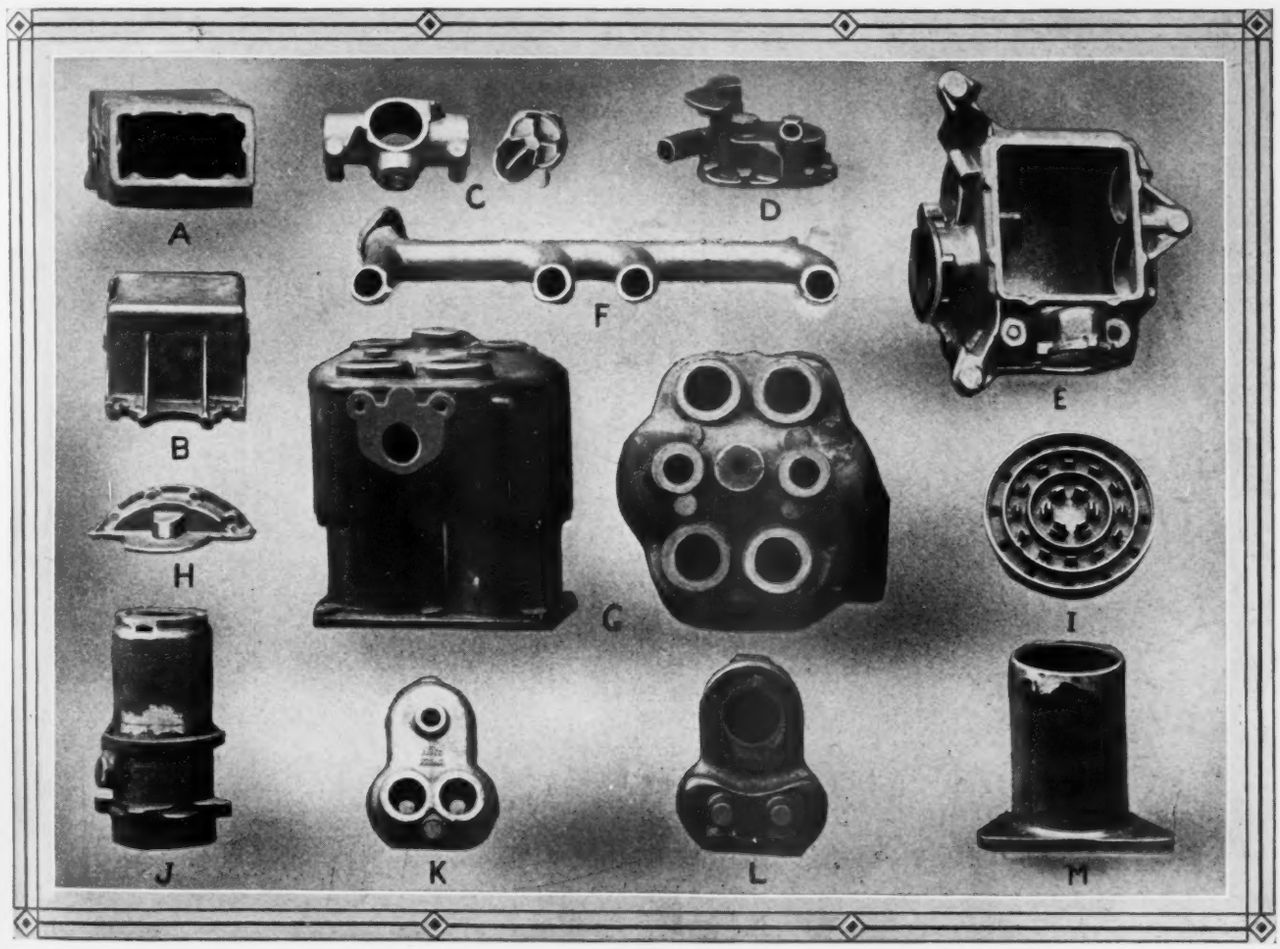


FIG. 24—MISCELLANEOUS, GRAY IRON, AUTOMOBILE CASTINGS

NEWARK FOUNDRYMEN'S ASSOCIATION.

"The importance of a chemist to the foundryman," was the subject of a paper read by C. L. W. Pettee, at the meeting of the Newark Foundrymen's Association, held at the Continental Hotel, Newark, N. J., Oct. 6. An interesting discussion followed Mr. Pettee's address. While some of the members thought a foundry foreman should be capable of judging his cupola mixtures, the general impression prevailed that a chemist should be called in to aid in solving such difficult problems.

SIZES OF EXHAUST PIPES FOR TUMBLING BARRELS.

Question:—Can you give us any information concerning the allowance to be made for the increased friction in the small pipes of a fan exhaust system connected with tumbling barrels and emery wheels? What relation should the combined area of the smaller pipes of the system bear to the main line of the fan outlet?

Answer:—It is customary to make the main trunk line of the exhaust system for tumbling mills equal in cross sectional area to the total area of all connections. It is desirable to select a fan whose inlet or outlet, whichever is the smaller, will not be any less than the area of the main trunk line connecting with it. Preferably the fan opening should be more. Some of the best designers of exhaust systems choose fans whose smallest openings are approximately 40 per cent more than the area of the main pipe. The accompanying table gives the size of pipes for tumbling barrels of various sizes.

A good dip for pickling brass castings that are to be tinned consists of oil of vitriol 1 gallon, aqua-fortis 1 gallon and common salt, 1 ounce.

SIZES OF PIPES FOR TUMBLING BARRELS.

Diameter of mill, inches.	Length of Barrels. 36 inches.	48 inches.	60 inches	72 inches.	84 inches.
24	4-inch pipe	4-inch pipe	5-inch pipe	6-inch pipe	6-inch pipe
30	4-inch pipe	4-inch pipe	5-inch pipe	6-inch pipe	6-inch pipe
36	5-inch pipe	5-inch pipe	6-inch pipe	6-inch pipe	7-inch pipe
42	6-inch pipe	6-inch pipe	6-inch pipe	7-inch pipe	8-inch pipe
48	6-inch pipe	6-inch pipe	7-inch pipe	8-inch pipe	8-inch pipe

Machines requiring 7 or 8-inch pipes with only 6-inch trunnions should have a 6-inch connection to each end.

INTERCHANGEABLE FLASK EQUIPMENT

A simple and economical method of making flasks interchangeable without machining --- Malleable iron keys for clamping the flasks

BY GEO. MUNTZ

WHEREVER cast iron flasks are used, more or less trouble is always experienced interchanging them. The templates that must be made in order to drill the flasks uniformly are expensive and for this reason are not extensively used by foundries making their own flasks. The system that will be described insures perfect interchangeability, although no machining is necessary. A triangular pin shown at *A*, Fig. 1, is used, which is very wide, thus insuring a perfect guide when the copes have to be carefully lifted. These pins are wedge-shaped at the bottom and are wedged between the flask and a cotter, as will

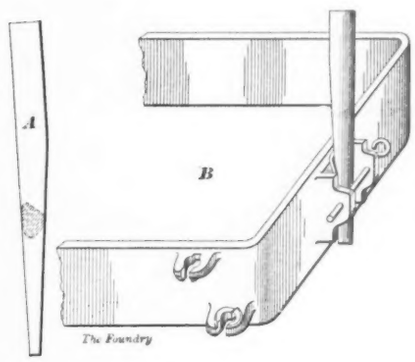


FIG. 1—FLASK PIN AND METHOD OF WEDGING THE SAME IN THE FLASK

be further explained. These pins are made of different lengths but are of the same section at the base, and can be used on all sizes of flasks from 10 inches to 6 feet square. If a cope, nearly flat, is to be lifted, the molder uses short pins, while long pins are used if there are heavy pockets of sand in the cope and a good guide is desired.

Lining the Grooves.

The grooves in which the pins engage are bushed with white metal of special composition, and two lugs are located on either side of the groove containing openings for the removable cotter. It is between this cotter and the white metal bushing that the pin wedges itself, as shown at *B*, Fig. 1. It is assumed, of course, that the flasks of the same sizes are uniform, and that they can be used for copes, drags or cheeks. There is another advantage in

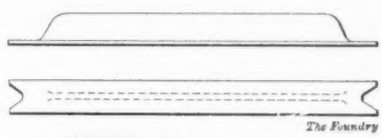


FIG. 2—GAGE USED FOR SETTING THE MASTER PIN

the use of cast iron pins, and that is, that they will not bend, but will break before the lugs of the flask give way if two flasks do not fit perfectly, and it is always cheaper to replace the pins than the flasks.

The Flask.

The method followed in making these flasks insures their interchangeability. A cast iron table is used, approximately 10 feet long, in which is milled a T-slot, Fig. 5. The two master pins from which all of the grooves are cast are mounted on shoes and are permitted to slide freely on the table. At the bottom of the shoes is placed a guide *a* which engages in the T-slot and forces the master pins to move in a straight line. The slot is in the form of a double T, so that a flat piece *R* can be moved along with the master pins, and thus prevents the white metal from filling the slot. The master pin *A* is secured in place by a dowell pin *M*, and is the standard, while the master pin *B* can be moved freely on the table, and can be adjusted for any standard size flask. If a flask of a certain size is to be bushed, the master pin *B* is set by

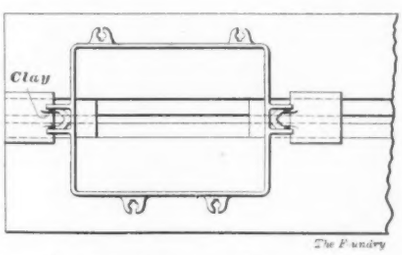


FIG. 3—POSITION OF FLASK ON THE TABLE WHEN CASTING THE BUSHINGS

means of the gage shown in Fig. 2. The flask is then placed on the table when the bushings are to be cast, as shown in Fig. 3, and clay is used at points where the white metal is liable to flow out. To remove the flask, the dowel of master pin *A* is taken out and the latter is forced back permitting the easy removal of the flask. The fins are then cut off and the flask is ready for use without further machining.

The molding of these flasks also involves a number of interesting operations. The grooves, which are to receive the bushings, are roughed and cored out, as shown in Fig. 4. The core is somewhat difficult to make as it consists of three small cores. Core box *A*, Fig. 6, shapes the lugs on either side of the groove,

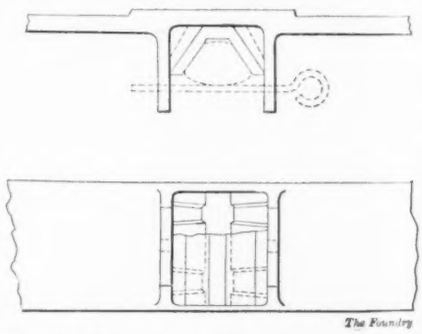


FIG. 4—GROOVES IN WHICH THE BUSHINGS ARE CAST

while core box *B* forms the grooves and roughing; and core box *C* makes the openings for the cotter which holds the pin. The three parts of the core and the method of assembling them are shown at *D*.

Flask Clamps.

In addition to the guides, these flasks are provided with a novel clamping device. On each flask are cast, on two opposite sides, lugs similar to those cast on ordinary flasks. These lugs are open and contain two tapering bosses, as shown in Fig. 1. When the flasks are clamped, malleable iron keys, similar to those shown in Fig. 7, are used. These are inserted in the openings in the lugs and are turned in the direction indicated by the arrows. The inclined bosses act as wedges, and the flasks are thus securely fastened.

CHARGING FLOOR LABOR PER TON OF IRON MELTED.

By W. J. Keep

Question:—We would like to know, approximately, the amount of iron a given number of men can charge in a cupola per day. This includes weighing the charges, taking the stock from the yard to the charging floor, etc., and handling not only the iron but the coke and limestone as well. How much iron can two men handle on a charging floor, and how many additional men would be required to charge various amounts up to 100 tons per day? These men, of course, take care of the cupola in the morning, that is, repair the lining, make up bottom, etc.

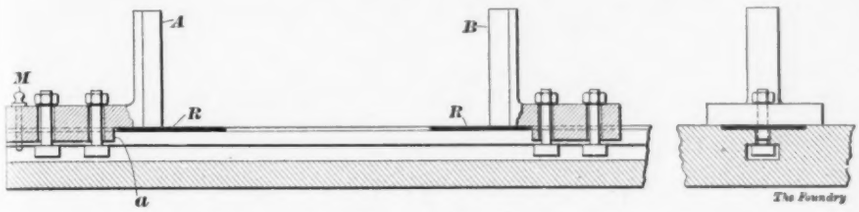


Fig. 5—Cast Iron Table on Which Flasks are Finished

Answer:—Conditions vary to such an extent that no fixed rules can be followed. It is not practical to add a man on a hot day and to take him off when the weather is more favorable. The force should be sufficient to do all of the necessary work. Below I give the number of men actually employed in a number of foundries in the vicinity of my shop.

(1) One man does all of the work for a 2½-ton melt, 3 tons being the limit. He repairs his cupola, taps out, wheels and weighs the iron, limestone and coke, wheels out the sprues and charges all of the material in the cupola.

(2) Another stove foundry employing 166 molders and melting 34 tons of iron requires only five men to operate its cupola. This includes the handling of all material, and one man taps out the iron while four men weigh the material and charge the cupola. These men wheel out all the sprues, and as no cinder mill is used, pick over the bottom. However, a sixth man is employed to daub ladles and tap the slag when melting. The coke charge is 2,400 pounds on the bed and 300 pounds of coke for the succeeding charges. The last three charges are reduced to 250 pounds, while the iron averages 3,000 pounds per charge. The material is handled in the yard in wheelbarrows, and is hoisted to the charging floor by an elevator.

(3) Another stove foundry requires six men for a melt of 22 tons of iron. The material is conveyed in wheelbarrows up an incline. The ladles are daubed by a separate man.

(4) Another large stove foundry, melting 80 tons of iron in three cupolas, requires 15 men for handling this material. The iron is charged in cars handled by a crane, that reaches all parts of the foundry yard. The limestone is conveyed to each charging platform by a crane. The charges are weighed and the sprues, coke, etc., are placed on the car with the iron and these charges are run to each cupola over tracks. Flat cars provided with boxes are used in the foundry for handling the sprues and scrap, and these after being conveyed to the yard, are hoisted by the crane to the weighing platform or to a storage track. Fourteen cars of coke are loaded and placed on the storage tracks for each succeeding day's melt. This work requires two men in the yard, two men on the weighing platform, four men at each of two cupolas and two men at the third. Including the crane operator, 15 men are required for the 80-ton melt. The ladles are daubed by another employe. The man who taps the iron also keeps the slag running. One hundred tons could be melted by this crew, but the distribution of the work in the foundry would necessitate the installation of another cupola, and therefore, four additional men. Four men could easily do the work at each of the two larger cupolas in the winter time, but inasmuch as an additional man had to be added at each furnace in summer, it was decided to employ the entire crew throughout the year.

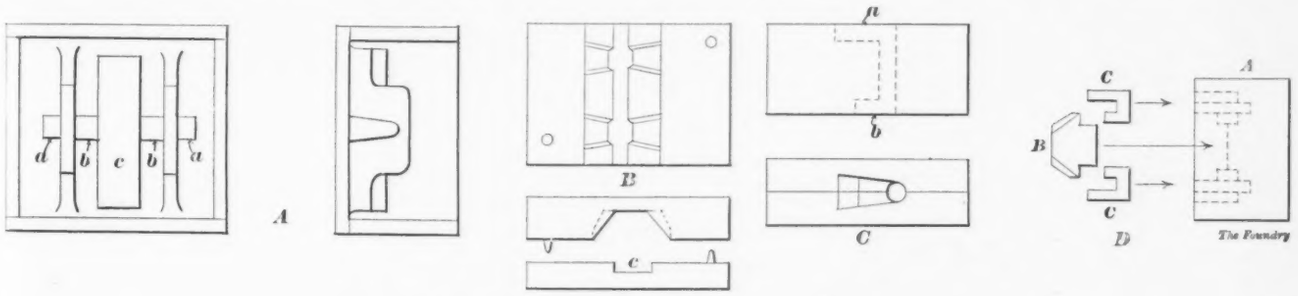


Fig. 6—Core Boxes and Cores for Forming the Grooves

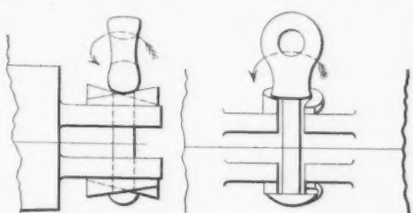


Fig. 7—Malleable Iron Keys for Clamping Flasks

The melt compared with the necessary charging floor labor can be summed up as follows:

(1) One man—3 tons.
(2) One man—6 4/5 tons.
(3) One man—3 1/3 tons.
(4) One man—5 1/5 tons.

The labor of the second foundry shows that the melt is most economical in the percentage of labor employed. I am not certain whether uniform iron can be obtained by dumping the entire charge of coke and iron into the cupola at once, although in all of these cases the charging was done very carefully.

The American Blower Co., Detroit, is sending to the trade a handsomely illustrated circular entitled "Just a Little Noise About a Silent Engine." The merits of the vertical self-oiling engine made by this concern are briefly touched upon, and a number of complimentary testimonial letters are included.

The Foundry Practice Course of a Modern Australian Trade School

BY J. F. BUCHANAN

AFTER all, the problem of the *good molder,* or the craftsman of any description, is mostly an educational matter, but whether the employers or the state should educate the artisans of the future is a question which cannot be settled off-hand. In certain parts on the continent of Europe and in Australia, the responsibility of teaching the technicalities of trades and crafts, arts and sciences, has been assumed by the government with very flattering results. Technical education is a recognized necessity in every progressive center, and I think the rising generation of this "Sunny New South Wales" is extremely fortunate in having the broadest system of technical instruction allied to the state school program.

In November, 1889, the government created a technical education branch of the public instruction department "to provide systematic and practical instruction in the arts and sciences." Two years later the handsome pile of buildings known as "Sydney Technical College and Technological Museum," was ready. The Sydney technical college, shown in Fig. 1, is thoroughly equipped for the higher education of students.

Growth of the School.

Since 1892, the work of the Sydney technical college has increased by leaps and bounds, and the diplomas of the institution have gained esteem in manufacturing and professional circles. The various courses are graded from the

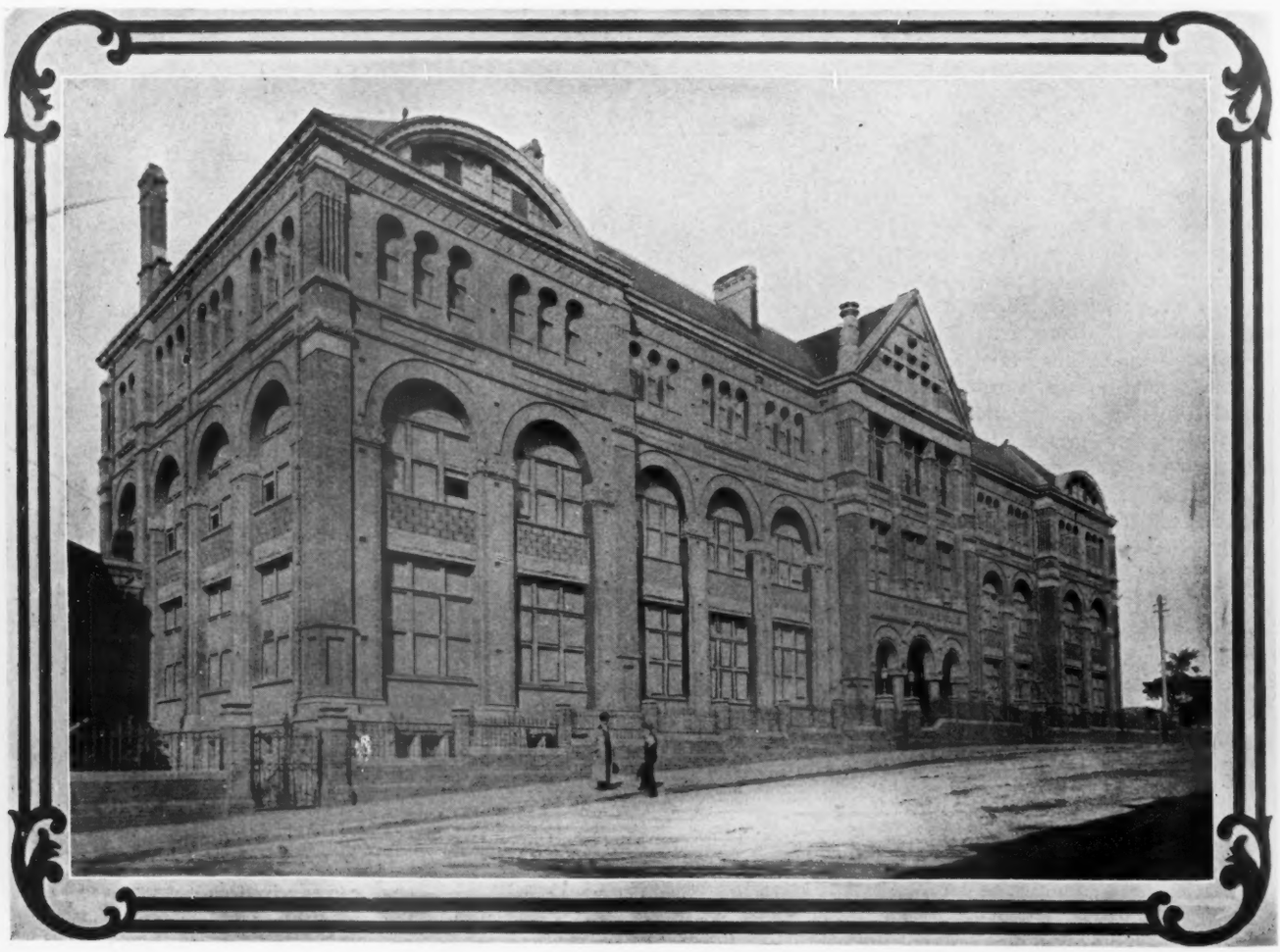


FIG. 1—SYDNEY TECHNICAL COLLEGE, SYDNEY, N. S. W.

FIG. 2—A VIEW OF THE FOUNDRY SHOWING THE STUDENTS AT WORK

elementary stages on to the level of the faculty degrees, and, speaking by the "calendar," the subjects include everything worth studying from A to Z —agriculture to zincography and zoology. In addition to the agricultural continuation schools and the manual training schools, which are meant to carry on the general education of the children, with special emphasis on science and scientific methods to prepare them for the higher studies of the colleges, eight branch colleges have been built in the more settled districts of the state, and numerous technical schools have been started to meet the needs of rural and suburban districts. So that free education on modernized lines, technical instruction of the most practical kind, and opportunities of bringing the schools into touch with industry, comprise the generous educational scheme placed at the service of "Young Australia."

Foundry Depar.ment.

With a passing word of praise for the work of the education department,

FIG. 3—AN EXHIBIT OF CASTINGS MADE BY THE STUDENTS

I must leave a tempting mass of statistics and cheering details, so as to confine my attention to the foundry training classes. Due to the courtesy of the minister of education, the Hon. J. A. Hogue, and the officer directing the technical branch of public instruction, J. W. Turner, I am permitted to describe and illustrate the work of the foundry class at Sydney technical college. This class was established in 1893. The primary intention of the department was to reach and help those working at the trade. The course extended over two years, as follows:

First Year—Principles of molding, sand and how to select it, mixing sand, quantities of ingredients for green, dry and loam molding and coremaking; methods of molding in green sand, dry sand, loam, stereotype or plate; coremaking and drying stoves; quality and characteristics of pig iron or scrap; mixing of scrap and pig iron; chills and chilled castings, molding boxes.

Second Year—Burning-on and joining cast iron or brass, working furnaces and fuels used; construction of furnaces; brass founding and brass furnaces; contraction and expansion of metals; bending and breaking castings by contraction; foundry management; piece and statue molding; bell founding, striking out work on bed; different methods of making cores in loam and brick-work.

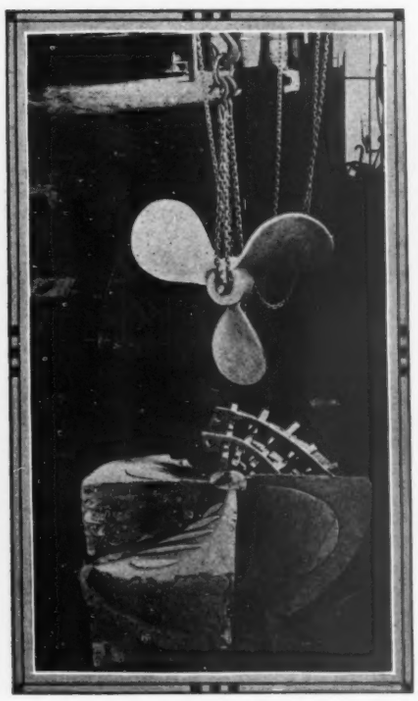


FIG. 4—PROPELLER MADE BY AN 18-YEAR OLD STUDENT

These students do not necessarily take the first year's lessons. It often happens that a young molder is nearly out of his apprenticeship before he realizes the value of technical training. If he wishes to take a course supplementary to his workshop practice, he may be admitted to the second year class on giving satisfaction as to his fitness.

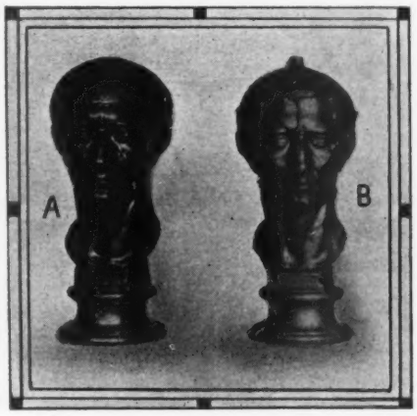


FIG. 5—A STUDENT'S MASTERPIECE—BUST OF JULIUS CAESAR *B* AND THE PLASTER PATTERN *A*

Day and Evening Classes.

At first the class was held in the evenings only, but in 1899 day classes were started for the third year students graduating in the mechanical and electrical engineering department of the college. Day students are required to go through with the patternmaking course before they begin in the foundry—a very sensible arrangement—and even although they may have no intention of connecting themselves with the foundry industry, *all* have to work on the floor and be examined in foundry practice. The majority of these students are looking forward to a career as consulting, inspecting or managing engineers, and having done practical work they are better fitted to inspect and design castings with less risk of making themselves look foolish in the eyes of practical foundrymen. Foundry management is included in the syllabus, and it has been noted that these students show up well in theoretical examinations, whereas the evening students, who are mostly apprentice molders, excell in the practical work.

Buildings.

The buildings comprise lecture rooms, laboratories, workshops, library, museum, class rooms, lockers and offices. The foundry workshop is 75 feet by 35 feet. It is equipped with an overhead traveler capable of lifting five tons; a cupola of 30 inches diameter, of the hinge bottom type, and air belt. The air is supplied by a Roots blower, driven by a 6-horsepower steam engine. The drying stove is 8 feet square. Fig. 2 shows one-half of the foundry with some of the students at work, the teacher with sleeves rolled up surveying the class, and visitors looking on. In view of the work done here, including marine, mining, architectural and general engineering, molding machine work is not included in the course. Nevertheless, there is a big variety of work to be done—work of a kind which compels the student to think, and most of the castings are being put into use in the various departments of the college.

Work of the Students.

A display of castings, Fig. 3, shows some very creditable work in loam, dry sand and green sand. Some fine ornamental castings are also shown, but separate photographs would be required to do them justice. A fine illustration of propeller work is shown in Fig. 4. This casting is made with strickles and templates only; the pattern for the hub is run up in loam and the blades are formed in sand as shown. The three-bladed propeller wheel, which is hanging on the crane, was made by a boy of 18 years. All marking and setting was done by himself, no patternmaker assisted, as is common with this class of work. Another standard piece of work is a set of triple expansion cylinders, Fig. 7, *B*. The mold, cores, core irons, sand mixing, coring and casting is the exclusive work of the student, it being held to be better that none should share the thinking and responsibility. The lads attending this class are all desirous of becoming good all-around molders, and the teacher sets to work towards that

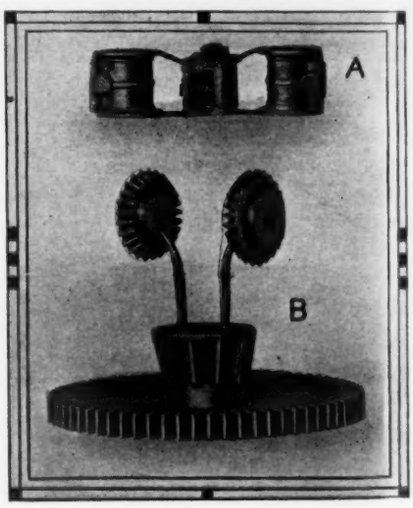


FIG. 6—INTRICATE SPECIMENS OF FOUNDRY WORK USED TO DEMONSTRATE METHOD OF GATING, THE USE OF DRAWBACKS, PARTINGS, ETC.

end by forcing them to become good all around thinkers.

The system insisted upon makes the student provide for every contingency in the production of the castings, and he gets credit for *all* of the work. He makes his own cores, cuts his own sand, and in cases where the job will be troubled with much contraction, or the casting is liable to suffer through being bound by core arbors or from other causes, he must make his own measurements and make allowances to that end.

Use of Plaster Models.

Another feature deserving of notice is the use of plaster models to demonstrate intricate coring and joining of mold parts, *A*, Fig. 7. The primary object in selecting such intricate work is to give the young molder confidence so that anything less or equally intricate given to him may not puzzle him. Certainly better pay follows better work and employers place their confidence more readily in the tradesman who has confidence in himself.

Beginning with the simpler forms of work, the students are taught the use of the rammer—and its abuse. The first molds made by beginners are cast in lead, the object being first to point out inaccuracies in the molding and perhaps the results of a too liberal use of water; and second, the danger of pouring molten iron into a mold that is too wet, too hard rammed, or badly vented. When satisfied, the teacher promotes the student to castings in iron, starting, if the boy shows aptitude, with a sheave, a pulley, a chain, link by link, then on to castings with cores. Lectures and blackboard exercises enter largely into the teaching. The latter are very helpful in illustrating the making of bells, the building of loam jobs, rigs, cupolas, brass furnaces, reverberatory furnaces, and numerous other items that may occur to the lecturer. Quarterly examinations are held in both theory and practice. Students attending classes in all subjects are expected to keep notebooks. Notes on the lessons are to be neatly entered, and, wherever possible, sketches are to be made in the notebook. They are to be handed to the teacher at frequent intervals for inspection and any necessary correction.

Awards.

Some students note well, others work well. The honor students must do both. Prizes are awarded to those who take honors, and in addition to the departmental prizes, the lord mayor of the city awards a gold medal to the honor student of the second year. Honor students in the first year are presented with THE FOUNDRY for one year in addition to the college prizes. The gift is contributed by the teacher, William Taylor, who is one of the most respected and experienced foundrymen in Australia. Fifty years ago Mr. Taylor began his apprenticeship to the iron founding trade, and, to use his own words, he is "still learning." He is the proprietor of a historical Sydney foundry—The Paragon—a government contractor for all kinds of castings, and the amiable teacher of foundry practice at "The Tech." This last position is his greatest pleasure, and how well he fills it may be understood when I say that a foreman or a molder in this city just wants to proclaim himself one of "William Taylor's boys" to get a show. There are no intricate time cards, elaborate cost records or fancy check order books about his system of teaching. A boy is told to do a job well at all costs; he will learn to do it quickly at less cost that way.

Intricate Work.

Mr. Taylor has the "get there" methods, that leave an impression for all time. To illustrate, see Fig. 6, *A* and *B*. Mr. Taylor made those beautiful specimens of foundry craft to teach his boys lessons in joints, drawbacks, gating, ramming, venting and all the other technicalities of molding. Fig. 6, *B*, is a poem in wheels, which, with judicious color printing, might represent a pair of sunflowers on a fluted stand, and at *A*, Fig. 6, we have a triple expansion job in more senses than one. Let the man who thinks he knows it all study how to make these two jobs without burning-on or trickery of any sort. He will know a lot more after a trial. Finally, at *B*, Fig. 5, we have the student's masterpiece. This is a bust of Julius Caesar, which is only given to the painstaking student. It is a trial of patience. The plaster pattern, *A*, wears a perpetual frown owing to successive coats of shellac varnish. The casting is only 3/8-inch in thickness, and there is no core box to make the core either. The plaster mold in which the pattern was made is thicknessed for the core. The casting itself at *B* tells the rest of the story.

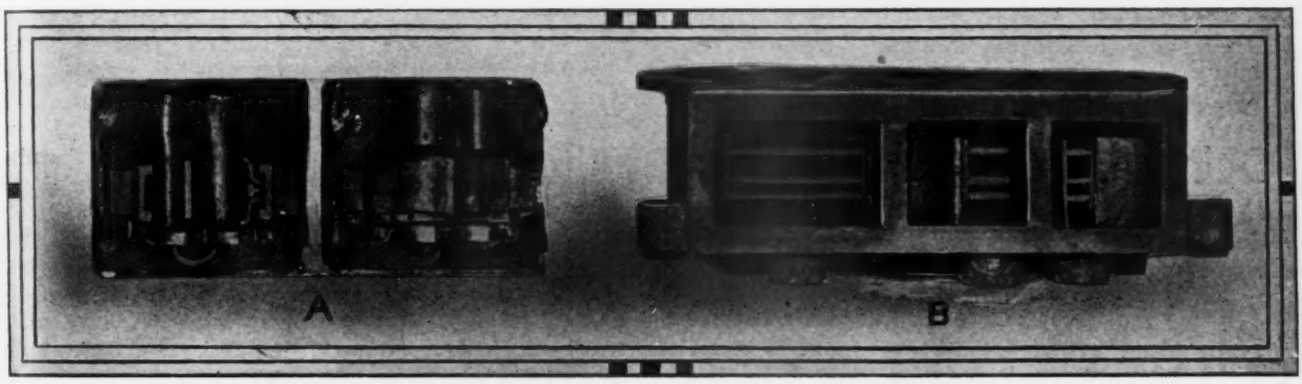


FIG. 7—PLASTER MODEL *A* USED TO DEMONSTRATE INTRICATE CORING, PARTING, ETC. TRIPLE EXPANSION CYLINDER *B* MADE BY THE STUDENTS

Many more examples of castings made by the students could be shown—lathes, pumps, pipes, wheels—castings that are so familiar to the practical foundryman that illustrations are uncalled for. Castings that serve to develop the individuality of the student in all the technicalities of molding and demand some intelligent handling, and a practical knowledge of the whole routine of foundry practice. One of the main drawbacks to the inauguration of foundry trade schools, and perhaps the chief barrier to the progress of technical training, is the difficulty of disposing of the products of student labor—the difficulty of finding an outlet for the output. This difficulty does not exist here.

We have a government institution, and it can be fostered and fed and employed in a style that only a govern-

ment could afford. Quite recently the officer directing the technical branch of public instruction (J. W. Turner) made a grand tour of the world inspecting technical colleges in all the great centers and gleaning all the latest methods and appliances employed in training students in every branch of science and art and industry. The value of that kind of inquiry cannot be overestimated; it is beginning to bear fruit already in higher organization, higher standards of examination and the adoption of newer and surer means of imparting knowledge and instruction. Many past students of Sydney Technical College are doing well in other parts of the world, but principally in America, in Germany and in Great Britain. The diplomas granted by this college are esteemed quite as much as the average university parchment, and this is due to the modern spirit pervading the directorate and teaching staff, and the rigid observance of disciplinary rules of which the following is only one example:

Every lecturer, teacher or instructor is authorized to have recourse to such disciplinary measures as are hereunder defined, that is to say:

For disorder, a student may be censured in the following manner, viz.:

(a) By silent admonition.
(b) By naming him before the class.
(c) By private rebuke.
(d) By rebuke before the class.
(e) By being required to vacate his place in class temporarily.
(f) By the imposition of a fine not exceeding £1.
(g) By being suspended and reported to the director (resident master) of the college, who shall report to the officer directing technical education (superintendent).
(h) In the central college, by being reported to the officer directing technical education.
(i) By exclusion from classes for a limited period.
(j) By expulsion.

A record shall be carefully kept by the teacher of every case of discipline from (d) downward, inclusive.

Enough has been written to show that Sydney Technical College can live up to its motto, "knowledge and skill, theory and practice," and if you think otherwise, I shall have to convince you by figures, figures, figures.

FOUNDRY AND MANUFACTURERS' SUPPLY ASSOCIATION MEETING

THE annual meeting of the executive committee of the Foundry and Manufacturers' Supply Association was held at the Cadillac hotel, Detroit, Tuesday, Oct. 12. A joint meeting was held with the committee representing the Detroit Foundrymen's Association, and F. T. F. Stephenson, chairman of the Detroit general committee, outlined the plans that had been tentatively decided upon for the 1910 convention. The week of May 30 was suggested as the most desirable time, and the Michigan State Fair Grounds as the most suitable location for holding the meetings of the allied foundrymen's associations, as well as the exhibit of the Foundry and Manufacturers' Supply Association. The buildings will provide ample space for the display of all classes of foundry equipment, and there are numerous railroad sidings affording excellent shipping facilities. The members of the executive committee of the Foundry and Manufacturers' Supply Association, accompanied by the members of the Detroit general committee, visited the Fair Grounds and all were well satisfied with the accommodations offered.

A. T. Waterfall, president of the American Foundrymen's Association and Joseph T. Speer, vice president, who is also president of the Pittsburg Foundrymen's Association, attended the meeting in the interests of their organization. Mr. Waterfall stated that favorable reports have been received from the officers of all of the allied foundrymen's associations, and that the hearty welcome extended by the foundrymen of Detroit foreshadows a large attendance. Jos. T. Speer expressed himself as well pleased with the arrangements, and promised that the Pittsburg Foundrymen's Association will, as usual, be well represented. The entertainment features outlined will consist of a moonlight ride on the river, as well as a smoker. For the visiting ladies, a theater party and an automobile sight-seeing trip through the parks and to points of interest in Detroit and vicinity, have been outlined.

After the return of the executive committee from the Fair Grounds, the business session was continued. The financial report of the Foundry and Manufacturers' Supply Association showed a large surplus, as against a deficit in the previous year. It was pointed out by the secretary that when the executive committee met in Cincinnati in February, it was decided to provide against the recurrence of a shortage, and it was agreed to curtail expenses wherever possible and to proportionately increase the cost of space to exhibitors. It was furthermore agreed that in the event of a surplus, such amount in excess of $1,500 should be declared as a dividend to be divided pro rata among the users of space. The financial report was extremely favorable and it was decided that $1,500 be set aside as a sinking fund, and that a dividend from the funds in excess of this amount be declared and paid to those who exhibited in Cincinnati. The books of the association were audited by the International Audit Co., Chicago.

The question of the 1910 meeting was then considered and President F. N. Perkins was instructed to accept the invitation of the Detroit Foundrymen's Association to meet in that city next year. Mr. Perkins announced the resignation of J. H. Whiting, of the Whiting Foundry Equipment Co., as a member of the executive committee, and T. S. Hammond, of that concern, was appointed to fill the vacancy.

The following members of the executive committee were in attendance: F. N. Perkins, Arcade Mfg. Co., Freeport, Ill.; J. S. McCormick, J. S. McCormick Co., Pittsburg; S. T. Johnston, S. Obermayer Co., Chicago; John Hill, Hill & Griffith Co., Cincinnati; U. E. Kanavel, Interstate Sand Co., Cleveland; E. H. Mumford, E. H. Mumford Co., Philadelphia; E. A. Pridmore, Henry E. Pridmore, Chicago; J. S. Smith, J. D. Smith Foundry Supply Co., Cleveland; Geo. R. Raynor, Carborundum Co., Niagara Falls, N. Y.; H. R. Atwater, Osborn Mfg. Co., Cleveland; T. S. Hammond, Whiting Foundry Equipment Co., Harvey, Ill.; C. E. Hoyt, Chicago.

The Detroit general committee, which will have the foundrymen's convention in charge, follows: Frank T. F. Stephenson, chairman; Frederic B. Stevens, chairman finance committee; Joseph J. Wilson, chairman visitation committee; James S. Keightly, chairman reception committee; W. P. Putnam, chairman convention session committee; Melvin Henry, chairman ladies' theater party and sight-seeing committee; E. J. Woodison, chairman smoker and get-together entertainment committee; Oliver Phelps, chairman boat ride committee.

"GROWTH" OF CAST IRON INVESTIGATION

Results of a series of experiments to determine the cause of this phenomenon brought about by repeated heating

THE "growth" of cast iron after repeated heating was discussed in a contribution covering 101 pages, presented at the meeting of the Iron and Steel Institute, held in London, Sept. 27 to Oct. 1. The investigations were conducted jointly at the Victoria University, Manchester, Eng., by Prof. H. F. Rugan, of the Tulane University, La., who is prosecuting work as research fellow in metallurgy at the Victoria University, and Dr. H. C. H. Carpenter, professor of metallurgy at Victoria University. The fact that certain types of cast iron "grow" after repeated heating has been called to the attention of engineers by A. E. Outerbridge Jr., Philadelphia, who has been the principal, in fact, almost the sole worker, in this field. His chief contribution to the subject is entitled "The Mobility of Molecules of Cast Iron," published in the *Transactions of the American Institute of Mining Engineers*, 1905, volume 35, pages 223 to 244, although he has since made several other contributions on this subject.

The results of the investigations are summarized in the following 27 paragraphs:

1. The conditions under which the maximum growth of commercial cast irons are brought about by repeated heatings were determined. As a result a period of four hours at 900 degrees Cent. was chosen for the experiments.

2. It was shown that for growth to take place both heating and cooling are required. A given specimen grows no more under a 17 hours' than a three hours' treatment.

3. Methods of measurement of temperature and volume changes were decided upon. For the former, thermo-junctions and a direct-reading pyrometer were used; for the latter micrometer calipers reading to 0.0001 of an inch.

4. Test bars were heated in a cast iron muffle protected from the direct action of the flame by another muffle of fire-clay.

5. Three commercial cast irons were investigated. They grew at different rates and to different extents. After 94 heats they reached a constant volume. The growths varied between 35.21 and 37.50 per cent. An increase in weight was found in all cases.

6. The first step consisted in an attempt to correlate growth with chemical composition.

7. *Iron-carbon Series of Alloys Containing No Graphite.*—The carbon ranged between 4.03 and 0.15 per cent. Other constituents were low and constant.

A. *Sand Cast Alloys.*—White irons. The final result after 39 to 78 heats was a permanent shrinkage in all cases, which in six out of eight cases was not more than 0.5 per cent. A diminution in weight was found in seven out of eight cases, which followed nearly the same order as the carbon.

B. *Chill Cast Alloys.*—White irons—The results were similar to those obtained with the sand cast alloys, although the permanent shrinkage was not so fully marked.

8. The results obtained have given the authors the solution of the practical problem—the finding of an alloy whose volume remains constant even after repeated heatings at about 900 degrees Cent. Such an alloy would be a *white* iron with about 3 per cent of carbon, and only small quantities of other constituents of which, for this purpose, silicon is the most important and should not exceed about 0.2 to 0.3 per cent.

9. *High carbon medium silicon series, containing small amounts of graphite and 0.5 to 0.8 per cent of silicon.*—These alloys grew from the outset, and reached their maximum growth in 50 to 60 heats. The bar with the lowest silicon showed the smallest, that with the highest silicon the largest growth.

10. Two initially white irons, *A* and *M*, contracted for a certain number of heats and afterwards grew. It was shown that both these irons became gray on heating, and the change from shrinkage to growth was shown to coincide with the appearance of free carbon (temper carbon); and in the case of *M* as the free carbon increased, so did the growth. Free carbon, whether graphite or temper, was thus proved to be an indispensable factor in the growth of cast iron under these conditions.

11. It was shown by calculation with existing data, which are, however, not very satisfactory, that the growths of *A* and *M* observed may be accounted for by an expansion consequent on the deposition of temper carbon in accordance with the equation—

Iron carbide (Fe_3C) = iron (3Fe) + temper carbon (C).

12. The influence of silicon was next tested.

Iron-Carbon-Silicon-Series.—Alloys *N* to *S*, carbon, 3.4 to 3.98 per cent; silicon 1 to 6 per cent in steps of 1 per cent, other constituents low and constant. Growths of between 15 and 63 per cent were found. It was shown that they were, broadly speaking, proportional to the silicon present and far in excess of what could be caused by the conversion of combined to free carbon. In fact they were largest in the high silicon alloys which contained no carbon combined with iron.

13. The bars tested in paragraph 12 had been machined at haphazard, some from the gate, others from risers in different positions. The rate of growth was shown to depend on the position. Bars cut from the gate grew more quickly than those cut from risers. That end of a bar nearer the gate grew more quickly than the other. The ends of some of the bars grew more quickly than the centers.

14. Bars cut from comparable positions were next tested (*NN* to *SS* series). They were all cut from the top of a riser. They grew more slowly than the *N* to *S* series, but ultimately reached about the same growths.

15. It was quite obvious from the behavior of this series of alloys that *gases* played an important role in their growth.

16. The curves of rate of interest in weight were seen to be similar to those of growth, and established an intimate connection between the two.

17. The final increase in weight followed the same order as the percentages of silicon. It was shown to be the resultant of three processes, (*a*) a partial oxidation of carbon which diminished with increase of silicon and became *nil* at 6 per cent; (*b*) a probably complete oxidation of silicon, originally present as the silicide of iron, to a mixture of iron oxide and silica; (*c*) a partial oxidation of iron uncombined with silicon.

18. The growth of the alloys, *N* to *S*, was thus shown to be bound up with a change in the chemical condition of the silicon.

19. The gradual penetration of gases into the alloys during growth was studied microscopically in *P*, and the structural changes recorded. Large amounts of gas are dissolved at certain stages. Graphite is displaced from its original position—the spaces left are oxidized—and numerous small holes are formed. The structure is revolutionized.

20. *Iron-Silicon Alloys.*—*T*, *U* and *V*, silicon 0.65 to 2.71 per cent, containing no graphite, were shown not to grow appreciably after repeated heatings.

21. The influenec of gases on two members of the *N* to *S* series was studied.

Alloy *S*, which grew 62 per cent in a muffle, not only did not grow when heated in vacuo but actually contracted slightly (0.04 per cent). In doing so it gave up 1.11 times its volume of gas, which consisted of 87.5 per cent hydrogen and 12.5 per cent nitrogen. Another bar, after being heated in vacuo until it had ceased evolving gas, was heated in a muffle and ultimately grew 67.7 per cent. It was thus shown that the growth of this alloy is entirely due to the penetration of gases, and that the gases

it originally contains have no direct share in the growth. About 47 per cent of the penetrating gases consist of oxides of carbon. They are responsible for the oxidation of the iron silicide which is so closely bound up with the growth of this alloy.

22. The more rapid growth of the ends than the rest of the bar is readily explained, as they expose more surface to the penetrating gases.

23. The more rapid growth of the end of the bar nearest the gate of the casting is connected with the fact that it contains more dissolved gas, but the cause of it is not as yet clear.

24. Alloy *N*, which grew 13.5 per cent in a muffle, grew 11.1 per cent when heated to constant volume in vacuo. It gave up 1.17 times its volume of gas, which was almost exclusively hydrogen (98.5 per cent). As regards growth in vacuo this alloy thus furnished a complete contrast to *S*. The explanation suggested is that this iron, which is very close grained, does not give up all its gas on heating. Some of it remains permanently imprisoned. Its co-efficient of expansion being about 400 times that of the iron when it is liberated on heating, *e. g.*, at the surface of contact between the iron and the graphite plates, the pressure will be sufficient to produce a permanent expansion.

25. *N* appears to be an alloy whose dissolved gases are capable of causing a large growth, at any rate where external gases are removed.

26. The growth of *N* in a muffle is probably caused by the combined effect of both originally dissolved hydrogen and the penetrating oxides of carbon.

27. The research has thus disclosed, among the gray irons, alloys, *e. g. S*, whose growth in air on heating is entirely due to oxidizing gases penetrating their interior, and also alloys, *N*, where this may not be the sole agent, but where originally dissolved gases contribute to some extent to the growth.

Agencies at Work in "Growth" of Cast Iron.

The agencies at work in the growth of gray cast irons after repeated heating are discussed as follows:

Although the foregoing research has not settled all the issues it has raised, it appears possible to form a mental picture of the mechanism of the growth of annealing ovens, and other cast iron vessels, in ordinary practice. These ovens are gray irons. They contain graphite and silicon, whose presence has been shown to be so intimately connected with growth. They also contain manganese, sulphur and phosphorus, whose influence has not been investigated, and must therefore be left out of account. They contain some dissolved gases, and they are exposed in practice to the direct action of flame gases, the influence of both of which has been carefully studied. They consist of four main structural constituents, which may almost be considered as three.

1. A solid solution of iron silicide in iron and manganese.
2. Graphite.
3. Some combined carbon—pearlite.
4. Phosphide eutectic.

With repeated heating 3 tends to pass into 2. Only 1 and 2 will be considered.

It has been shown that after the first heating gases have penetrated to a certain depth, and also that 17 hours' heating produces no more growth than three. A certain time is, of course, required, depending on the size of the oven, and the rate of supply of heat for the oven to acquire a steady temperature, and the volume corresponding to this. The authors' view is that, although the gases penetrate to a certain depth during this period, possibly along slits existing between the graphite plates and the solid solution of silicide in iron, and through holes which exist here and there, yet they are not actually absorbed by the solid solution until the oven is cooling. During this absorption the oxides of carbon oxidize the iron silicide, in the first instance, at the boundaries of the crystals. This reaction is accompanied by growth and incipient disintegration. Minute cracks are formed. There may be a series of minute explosions, owing to the reaction between the dissolved hydrogen and the penetrating oxides of carbon. The mechanically weak graphite may be disintegrated and forced into holes originally existing in the metal. Nitrogen enters along with the oxides of carbon, and is absorbed to some extent. The net result is a slight growth of the oven by the time it has cooled to the ordinary temperature.

When the oven is next heated, the furnace gases penetrate a little further, owing to the fresh avenues opened up by the reactions just described. On cooling these reactions are repeated, and in this way more of the iron is disintegrated, and a further growth takes place. Simultaneously, if the iron is close grained, like alloy *N*, hydrogen and nitrogen are liberated in the interior at the boundaries between the solid solution and the graphite. Their co-efficient of expansion is so much greater than that of the solids that they exert a considerable pressure, with the result that the mechanically weak graphite is disintegrated, and appears to collect in the holes of the casting. Where the boundary between two holes consists of graphite, it is destroyed by this action, and the two holes become one.

As the heats progress these changes continue. After each heat the external gases have penetrated a little farther. Finally, they work their way right through the oven, the rate depending on its chemical composition, physical texture, etc. When this condition is reached the oven has grown to its full extent. Some of the graphite has been burnt off, all the silicide of iron has been oxidized, probably to a mixture of iron oxide and silica and some iron has been oxidized as well. The main cause of growth is disintegration of the material caused by the oxidation of the iron silicide. In close-grained irons the pressure of dissolved gases also contributes to the growth. At the conclusion of the process, the structure has been revolutionized; the oven has lost the properties of cast iron. It has no mechanical strength, and can be cut like a piece of chalk.

The authors have no hesitation in recommending that white irons should be tried for annealing ovens instead of gray. The most suitable composition appears to be an iron with about 3 per cent of carbon and as few impurities as possible. Of these silicon is the most important, and should not exceed 0.2 to 0.3 per cent. This iron would probably shrink slightly on repeated heating. The reason why an upper limit of 3 per cent of carbon is suggested is that white irons higher in carbon will tend to deposit temper carbon. Where this is the case, the material will begin to grow. Even so, however, the growth will never be as much as in a gray iron. It is possible that an oven constructed of white iron may prove to be unsuitable, because it may crack on heating. Should this difficulty arise, it may perhaps be overcome by modifying the design.

Comparisons with Mr. Outerbridge's Results.

The authors also state that while the experimental results obtained by Mr. Outerbridge and themselves are usually in general agreement in places where the same ground is traversed, it seems probable that Mr. Outerbridge's views as to the cause of the growth of cast irons after repeated heatings will have to be modified in light of the results obtained in this research. Their comparison with Mr. Outerbridge's result follows:

1. His statement that "the increase of free carbon does not account in any way for the enlargement of the bar" was doubtless true of the gray iron with which he was experimenting; and holds for gray irons generally. But it is not true of white irons which become gray on heating, and expand in so doing. So far as existing data permit of an opinion being formed, this change is quite enough to account for the whole of the growth observed, alloys *A* and *M*. The authors' experimental results with these two alloys are in disagreement with his opinion that "white iron in which nearly all of the carbon is in the combined form does not expand sufficiently to overcome the original shrinkage even after all of the combined carbon has been changed to graphite;" and conclusively show that it does.

2. Mr. Outerbridge states that his "enlarged bar (40.98 per cent) weighed precisely the same as before treatment." The authors have great difficulty in accepting this statement, which is at variance with their entire experience. His bar was heated in an iron pipe, the ends of which were stoppered with clay, at a temperature of 800 degrees Cent.; that is, under conditions which permitted of the penetration of oxidizing gases, and were thus very similar to those used by the authors. In not a single one of the numerous cases examined by them did the weight remain constant. Every gray iron increased in weight, and the growth has been shown to be connected with this increase in the most intimate manner.

3. The author's results have shown that Mr. Outerbridge's conclusion that "the astonishing change in volume is a molecular and not a chemical one, thus substantiating my original theory of the mobility of cast iron" is incorrect in this unqualified form. Their experiments connect in a very intimate way the growth of gray irons with a chemical

change in the condition of the iron silicide which is invariably present.

4. His statement that "The peculiar property of cast iron of increasing in bulk under the influence of heat is inherent in the metal, and has existed for all time" is also incorrect in this unqualified form. Alloy *S* is an exception. Its growth has been proved to be due entirely to the action of penetrating gases.

MOLDING A LOCOMOTIVE STEAM DOME CASTING.

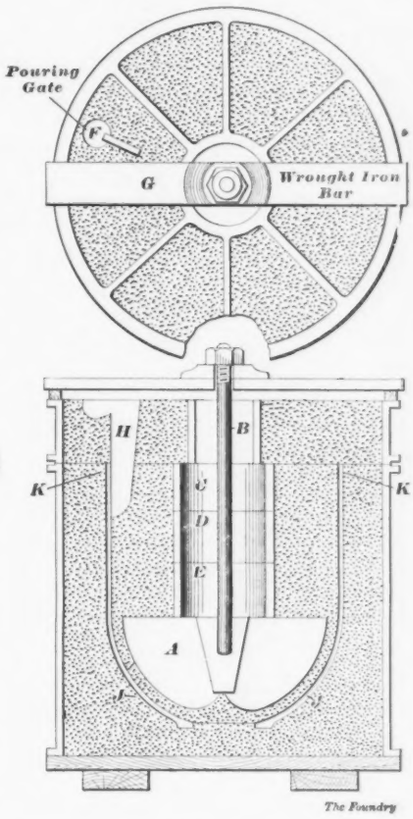
By Paul R. Ramp

While a locomotive dome casting is not very difficult to produce, nevertheless, in many foundries the practice is by no means modern. A dome casting is usually light and considerable trouble is experienced in making it reseasonably true to pattern. These castings are generally molded in a three-part flask and are cast with the dome upward. This makes it almost impossible to produce a true casting free from swell at the bottom edge. As a result, trouble is experienced in the machine shop owing to the excessive amount of stock at the point where the casting is turned off to fit the dome base. When the molder rams this part of the mold too hard to overcome the swells, he is generally rewarded with a cut or scab at this point instead of a swell. This results in a dirty casting, which is generally not disclosed until after it has been machined.

An improved method of molding this casting is shown in the accompanying illustration. In this instance the dome is cast with the small end down and the inside is lifted out with an arbor. The flask is made of sheet steel and is punched for vent holes. The bars of the cope are made of cast iron, bolted in place. The trunnions are cast separately and are likewise bolted in position. In making the arbor for this mold it is not wise to make the same the full length of the pattern, but it should be made just deep enough to tuck in the circle of the inside of the pattern. The arbor is shown at *A*, and when in use is secured to the cope by its stem *B*. Three rings *C*, *D* and *E* are used to weight the arbor against the lifting pressure of the metal. The top ring *C*, is wedged down from the cast iron bars in the cope. The method of gating this mold is shown at *F* and *H*. The cross bar that is used to carry the arbor is shown at *G*, while the arbor stem is shown extending through this bar in the top view of the mold, and the method of bolting the same is also indicated. It can readily be appreciated that this method is an improvement on the former practice of casting the large opening down, as it is much easier to prevent the casting from swelling at *J J* than at *K K*.

CASTING BRASS AGAINST STEEL.

Question:—We are making brass handles for automobiles which have steel chills cast in the handles. The castings, however, generate blowholes around the chills, notwithstanding the fact that we have endeavored to overcome this by cleaning the same with sulphuric and muriatic acids, and have also tried tinning, but without favorable results. The brass mixture we are using is composed of half return scrap consisting of sprues, gates, etc., and the other half is made up of rolled sheet clippings. We use two ounces of aluminum to each 100 pounds of metal as a flux. The price at which these castings are sold will not permit of the use of new metal.



Top and Sectional Views of Locomotive Steam Dome Mold

Answer:—The quality of the metal would not cause the blowing of the castings around the chills. This is due to moisture condensing on the steel chills. The atmosphere in a mold is saturated with moisture evaporated from the comparatively warm sand, and if cold steel such as the chill is introduced, condensation will take place on its surface and it sweats, to use a popular expression. This sweat is coverted into steam by the heat of the melted metal when the mold is poured. The steam having no means of escape repels the metal from the surface of the iron, forming blowhole cavities and sets up a disturbance in the liquid metal which causes dross and dirt. The remedy, therefore, is obvious. The chills should be heated and this is the only sure preventive of blowholes when casting iron in brass. Whenever it is possible to do so, the molds should be left open, and shortly before pouring the chills should be heated, placed in position and the molds immediately poured before the chills cool off sufficiently for the moisture to condense thereon. In some cases—and this is probably one of them—the experience of such a proceeding as the above would prevent its adoption, so that the chills must be handled like cores and set as the molds are made. Therefore, when the cause of blowholes is known, a little reflection will suggest that if the chills are warmer than the sand of the molds when placed therein, the danger of sweating is reduced as they will not be liable to cool below the temperature of the molds before they are cast. An important point in the avoidance of blowholes when using metal chills, is to have them just warm enough to be comfortably handled. In addition one maker of these handles coats his chills with a fine film of kerosene and this practice has proved very successful. Another good coating for chills cast in brass is silicate of soda or waterglass. After being coated the chill should be warmed in the core oven. Polished steel chills are frequently copper coated with good results. They should be dipped in a solution of water one gallon, blue vitriol one ounce and sulphuric acid one ounce. After being carefully dried they should be warmed before being placed in the mold. K. K.

A new work on "Metallography," by Dr. W. W. Guertler, is being published in 10 sections by Borntraeger Bros., Berlin, Germany, the first section of which has already been issued. As soon as the work is complete it will be published in book form. The first section contains a number of very interesting micrographs, and the succeeding sections promise to be well illustrated.

ENAMELED CAST IRON SANITARY WARE--VI

Method of molding closet tanks on jolt ramming molding machines of novel design --- Production of the tank lids

BY DILLEN UNDERHILL

THE cast iron enameled closet tank, when first introduced, immediately found public favor. The wood tank lined with copper, then in general use, had a tendency to open up at the joints, especially if the lining was not properly soldered, and frequently the water worked its way through the connections in the bottom. None of these difficulties is experienced with the enameled tank, and furthermore, being enameled in white it matches the bath tub, lavatory and the tile finish of the modern bath room. Owing to its shape, the tank involves many difficulties in molding. In some foundries the molds are made in a two-part flask and a frame, with an arbor supporting the green sand core. They are cast on the side. The frame of this arbor utilizes the closing pins for locating the core for side thicknesses, and suitable stops on the drag locate the height of the core. This frame is in the nature of a square ring, and the arbor is cast to it at one end, while the sand is rammed around this in a suitable form or pattern. There are objections to this method, however, because the mold is very heavy to be handled readily by two men, and furthermore, the losses are considerable, inasmuch as the metal frequently lifts the green sand core, and therefore the castings are often thick in the drag and thin in the cope. Frequently, the core will rise against the cope and will set so firmly that the

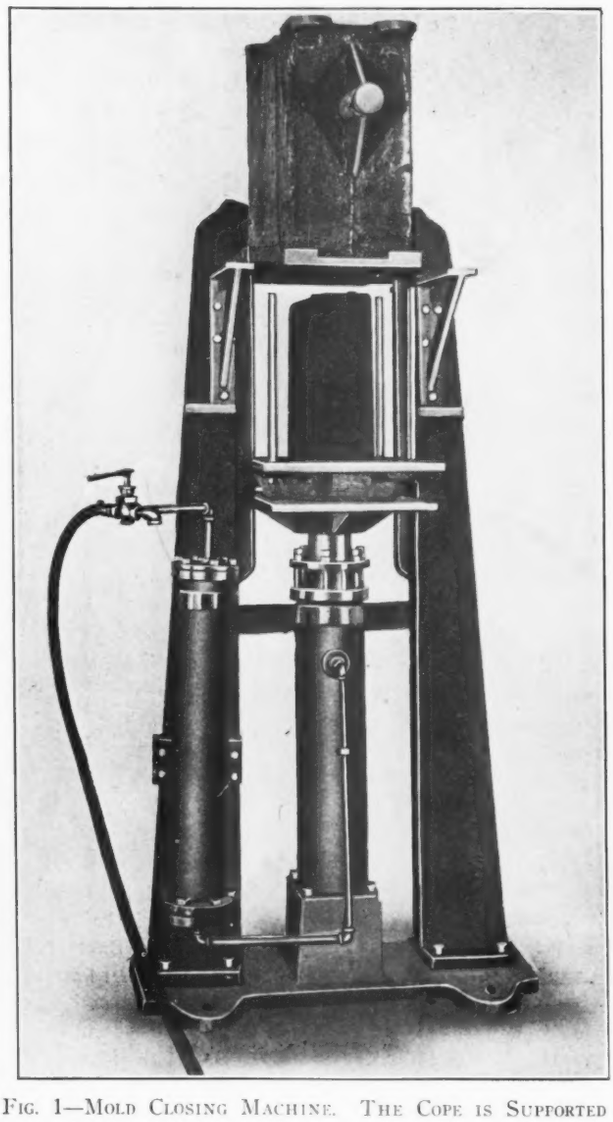


FIG. 1—MOLD CLOSING MACHINE. THE COPE IS SUPPORTED ON THE BRACKETS AND THE DRAG RESTS ON THE STRIPPING TABLE

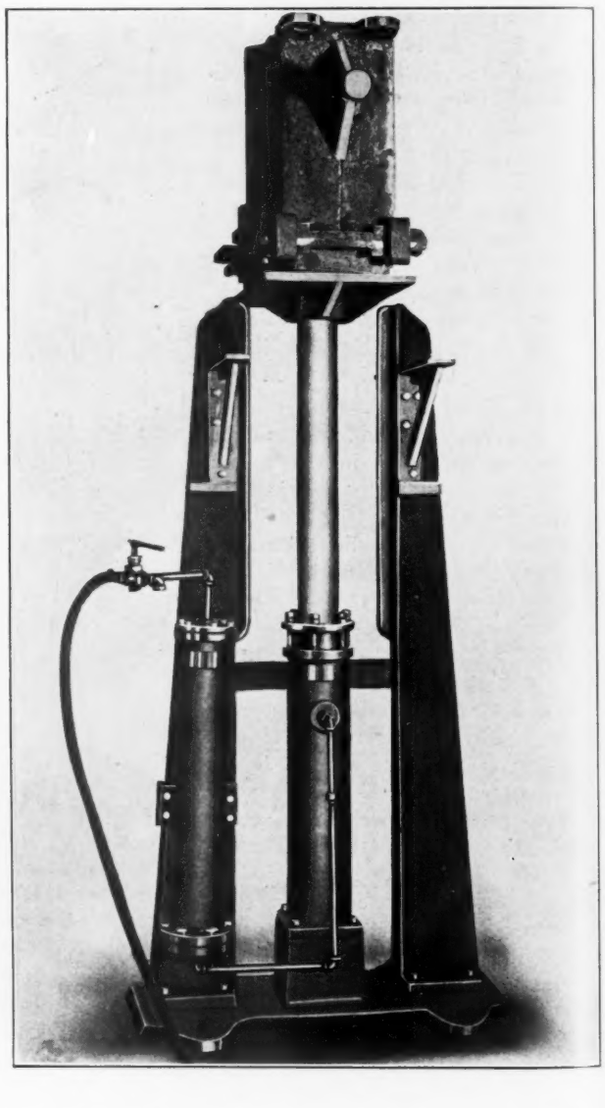


FIG. 2—MOLD CLOSED BY THE UPWARD MOVEMENT OF THE PLUNGER

metal cannot flow between these two parts of the mold. To overcome these molding difficulties a jar ramming molding machine was devised, and the entire mold is machine-made, as shown in Figs. 1, 2, 3, 4, 5 and 6.

The Closet Tank.

A style of tank which has met with much favor and is produced in large quantities, is shown in Fig. 7. The casting is of the box type, having one end open. It is about 18 inches deep, 21 inches long, 6 inches wide and from 3/16 to ¼-inch in thickness. It is attached to the wall by the lugs *AA*, which are hooks that engage the wall hanger shown in plan and section in Fig. 8. Single or double lugs, as shown at *BB*, Fig. 7, are also provided with openings for screws, which are used for attaching the tank to the wall. The openings in these lugs are cored in place with tin cores, similar to those used in stove plate work. The lugs *AA* are tapered and are approximately ¼-inch thick and 1 inch wide at the base, and are set flush with the ledge *E*. This ledge provides ample space for the wall hanger, Fig. 8, and also permits the tank to set against the wall. This provides an easy method of mounting the tank, and is used quite generally in modified form for hanging lavatories, sinks and other similar enameled ware that is hung to the wall. The outlet opening *C*, Fig. 7, is located in the center of the bottom of the tank, while the inlet opening *D* is located to suit the style of fittings used inside of the tank for controlling the flow of water.

The Tank Lid.

These tanks are made in many designs, but the changes chiefly consist in modifications of the curves and do not affect the principle of manufacture. Plan and sectional views of the tank lid, which is fitted loosely on top of the tank, are shown in Fig. 9. The lugs *FF* prevent the lid from sliding forward, and the edges on the other three sides prevent it from moving in any other direction. These lids are easily molded, two being gated on one plate, and being machine-made they can be produced very cheaply. The patterns are located on a table, the upper surface of which is machined, and provision is made for locating pins and a cam-lifting mechanism similar to that used for lifting the bath tub cheek or drag, which is attached to the table itself. Iron flasks are used and the molds are rammed on this table and are lifted away from the patterns by the cams.

Drag and Cope Machine.

As previously stated, jar ramming molding machines are used for molding the closet tanks. The drag is made

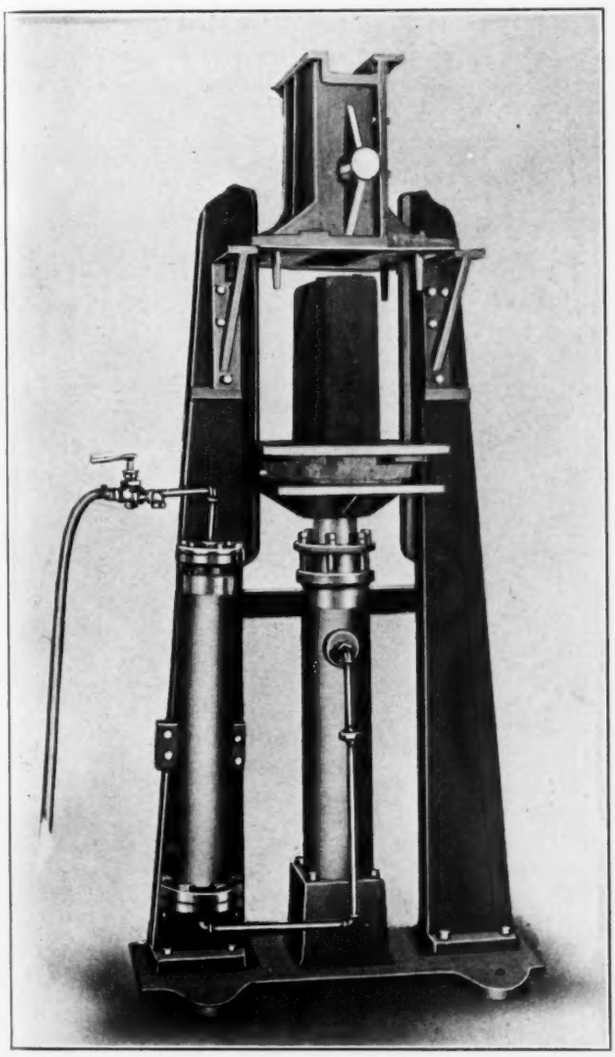


FIG. 3—MACHINE USED FOR STRIPPING THE DRAG MOLD AND FOR CLOSING THE FLASK. THE GREEN SAND CORE HAS JUST BEEN LOWERED AWAY FROM THE PATTERN RESTING ON THE BRACKETS

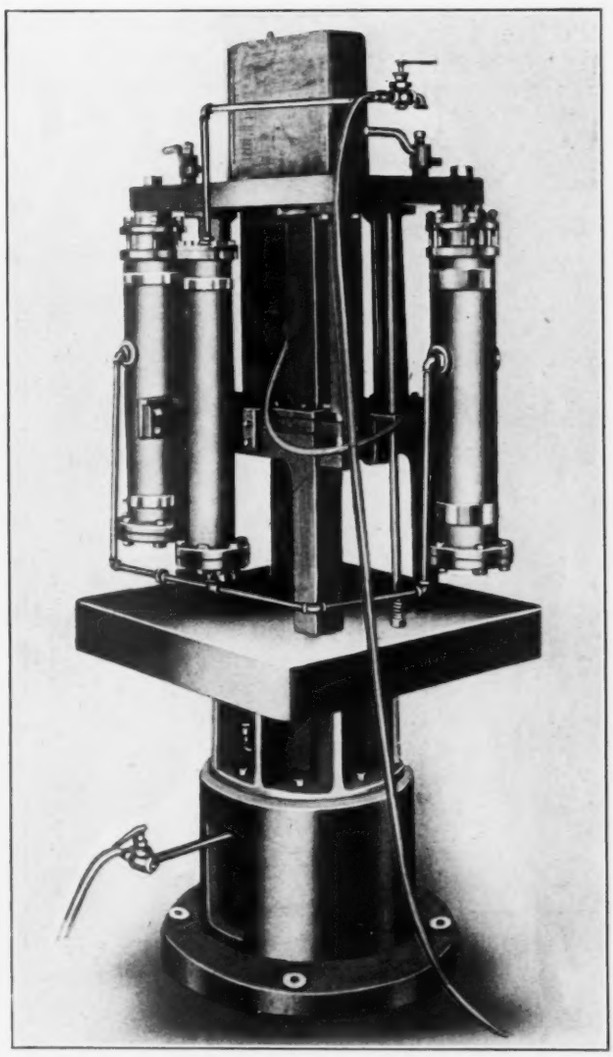


FIG. 4—COPE PATTERN AND STRIPPING MACHINE MOUNTED ON A JOLT RAMMING MOLDING MACHINE

on one machine and the cope on the other. One of these machines, with the drag half of the closet tank pattern on the table, is shown in Fig. 5. As the pattern has a tendency to move about on the table when the mold is being rammed, flat bars are attached to the table with studs or cap screws to prevent the pattern from moving too freely. For convenience in machining, the pattern is cast in two parts, being divided at the back of the tank on the line *XX*, Fig. 7. Locating pins are shown projecting upward from the parting surface of the pattern, which are used for locating the drag flask. Trunnions are also provided for turning over the pattern and drag flask after ramming. In Fig. 6 is shown the drag flask attached to the pattern with the end clamps driven over the wedges on the pattern and the flask.

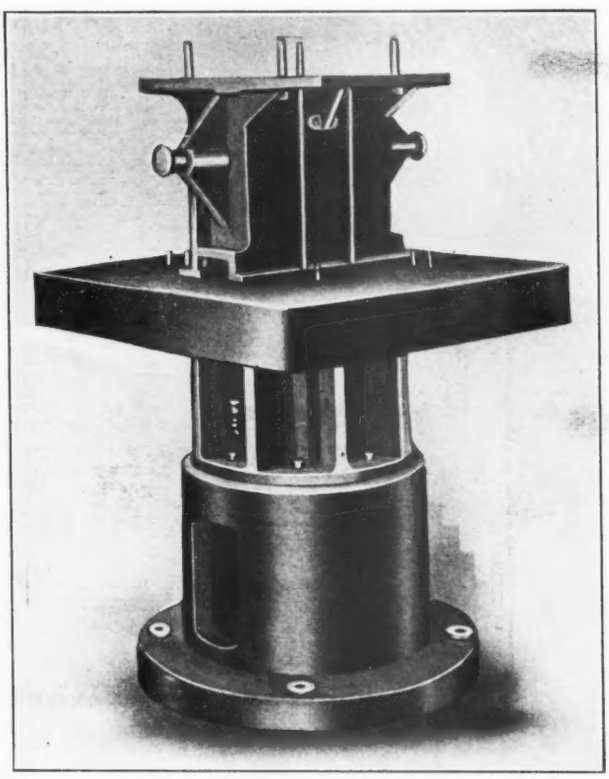


FIG. 5—JOLT RAMMING MOLDING MACHINE WITH DRAG, TANK PATTERN ON THE TABLE

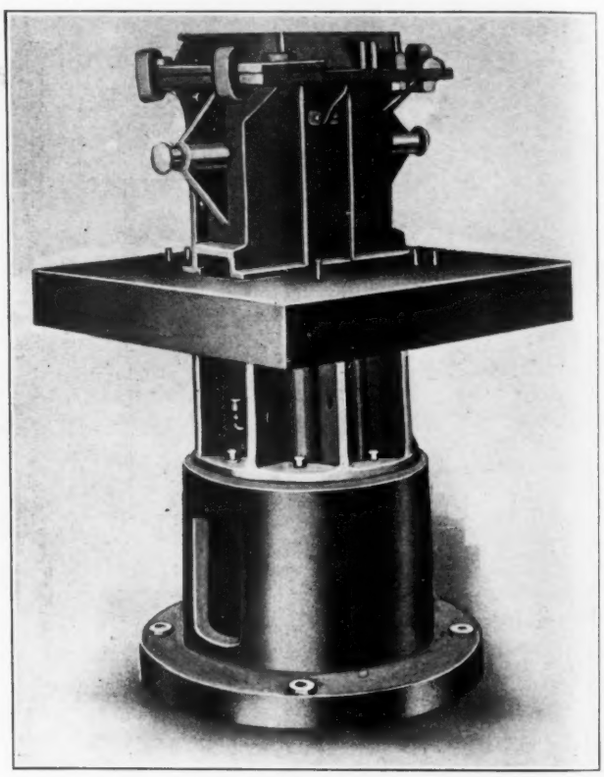


FIG. 6—DRAG FLASK CLAMPED TO DRAG PATTERN

The Drag Flask.

The drag flask is inclined about 30 degrees on the sides to hold the sand in place without the use of a bottom board. On the outside of the flask, lugs are cast which are planed with V-slots. These are used to locate the flask when closing the mold and are offset to prevent the flask from being improperly closed, that, is, 180 degrees from what it should be. The drag flask is cast with a rectangular bar extending across its width and to this, by means of a tapering pin, is attached the arbor which supports the large green sand core shown rammed on the drag resting on the stripping table, Fig. 3. The sand is shoveled through the bottom of the drag flask, which is open, and the mold and pattern are then jolted. A small amount of hand ramming is necessary to finish off the bottom to obtain a hard and level surface. The drag is then ready for stripping, and the pattern, and the drag flask containing the drag mold, are lifted off by a crane, turned over and placed on the stripping machine shown in Fig. 3. This machine both strips the drag half of the mold and closes the flask, as shown in Figs. 1 and 2. The plunger and table are extended to their extreme height, Fig. 2, and the drag mold, together with the pattern and flask, is placed on the table by the crane. After the clamps are removed the plunger descends carrying the drag and pattern until the projecting ears of the pattern come in contact with the brackets, shown on the front of this machine, and then stops its descent. The pattern is rapped with a mallet, and the drag and green sand core, by the downward stroke of the plunger, are permitted to drop away from the pattern, as shown in Fig. 3. The pattern is then removed by the crane, and is taken back to the jar ramming molding machine, where the previous operation is repeated.

Operation of the Cylinders.

The stripping machine is provided with two cylinders. When the table is lowered, both cylinders are filled with oil. A small pipe is attached to the bottom of the cylinder on the frame and is connected at a point near the top of the plunger cylinder. When air is permitted to enter the top of the cylinder attached to the frame, the oil is forced down and into the plunger cylinder, thereby raising the table. The oil and air pipe is made of such a size that with a given air pressure the plunger will travel at a certain uniform rate of speed. This can best be determined by repeated trials, as the limit of the rate of speed is not such an important factor as to prevent the use of a standard size pipe. As the pipe is of small diameter, only a limited amount of oil can pass through it in a given period, and therefore, the plunger rises and falls uniformly and does not destroy the mold. If the air is permitted to enter the plunger cylinder direct, the plunger will stick and start suddenly, and when once in motion will continue to move after the air is shut off, due to the large volume

of air expanding that is compressed in the cylinder. Furthermore, the table will descend suddenly when stripping and ruin the mold. When the stripper was operated by air a three-way position corresponding to it. At two diagonal corners are attached steel plungers operating in oil-filled cylinders, and these are connected with a middle cylinder to secure the same movement

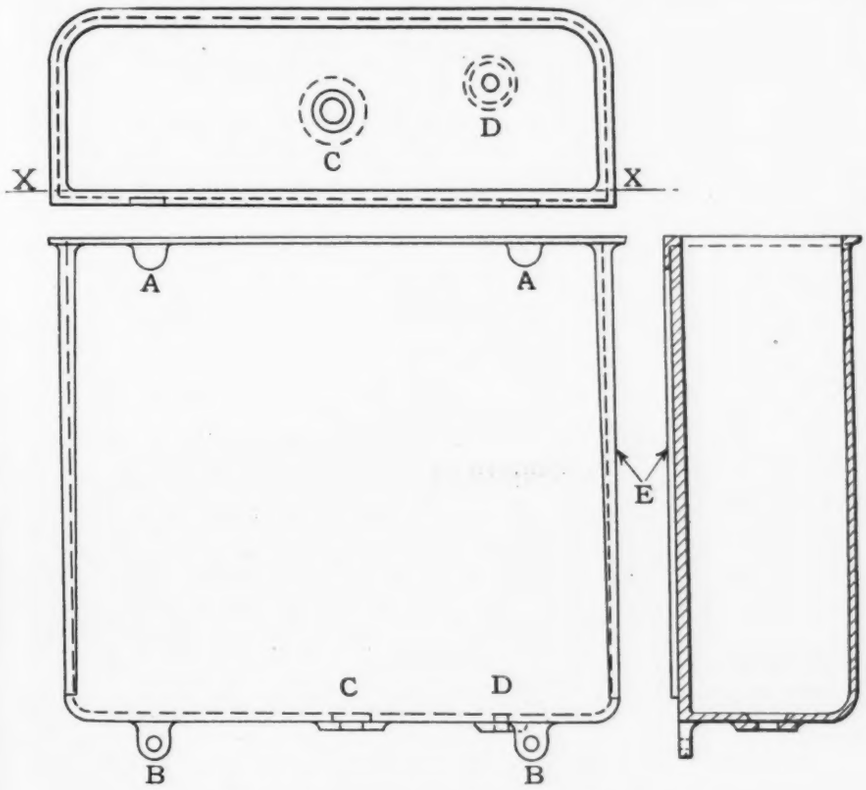


FIG. 7—PLAN, ELEVATION AND SECTIONAL VIEWS OF TANK

cock was used, and the pressure required varied from 80 to 100 pounds.

Cope Molding Machine and Stripping Device.

The cope pattern, together with the cope stripping machine mounted on a jar ramming molding machine, are shown in Fig. 4. The pattern is mounted on a central block which rests on a table provided with four legs, and this in turn sets on the jar ramming molding machine table. In short, the pattern is on a column so that with whatever jarring it receives it could not change its height. This likewise applies to the stripping plate, which is mounted on four corner columns, and these in turn rest on the four-legged table on the jarring machine. This fixes a positive parting line, and the pattern is also in a correct as that provided on the drag stripping machine, and furthermore, these cylinders insure a uniform movement of the table. A pneumatic rapper is placed underneath and inside the cope pattern, the air hose connection being shown on top of the four-legged table. The cylinders are attached to the sides of the table with cap screws, and also are provided with overhanging lugs to take part of the downward thrust. To prevent the table from rising too high, stop rods with springs on the ends are provided in case the air should be on too long in the middle cylinder. Additional guides are also shown on top of the table near the corners to overcome any tilting tendency. The two handles shown on top of the stripping table are made with beveled lugs fastened to studs, and are used to clamp the copes to the stripping table. The stripping table is also provided with locating pins which are not shown in this view. Three lines of hose are shown, the lower one conveying the air to the jar ramming molding machine, the middle one to the cope rapping device, while the top line carries the air to the stripping cylinder.

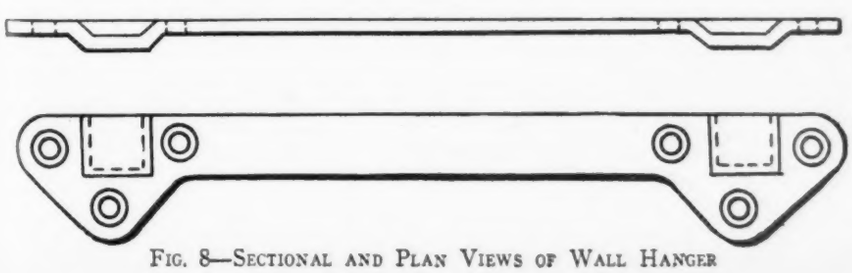


FIG. 8—SECTIONAL AND PLAN VIEWS OF WALL HANGER

Molding of Cope.

When molding the cope shown supported on the brackets, Fig. 1, the flask is placed on the stripping table over the cope pattern, the pouring gates or sprues are set on the stripping plate, the flask is filled with sand and the mold is rammed by the jar ramming molding machine. The pattern is then vibrated by the pneumatic rapper, the sprues removed and the stripping plate is raised, lifting the flask away from the pattern. The cope half of the mold is then conveyed by crane to the closing machine, Fig. 1. The cope flasks are provided with V-grooves to match the slots in the drag flasks. The cope half of the mold is placed on the brackets and is guided in closing the mold by four long closing pins placed in the drag flask, clearly shown in Fig. 1. The mold is closed by the upward movement of the plunger, and when the

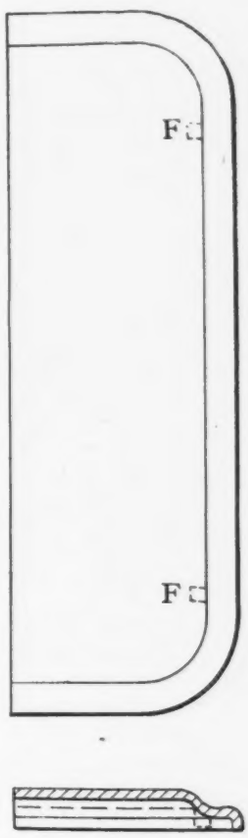


FIG. 9—PLAN AND SECTIONAL VIEWS OF TANK LID

drag flask comes in contact with the cope, the plunger is stopped until the end clamps are driven in place; the closing pins are removed and the flask in the position shown in Fig. 2, is then lifted off the machine by a crane and is placed on the molding floor ready for pouring.

As shown, the machines are entirely above the floor level, but when in operation in the foundry they are placed in pits and the table of the jar ramming molding machine is about 12 inches above the floor line. This permits the floor to be built up underneath the table and a casing with sloping sides is placed around the edge of this opening to prevent the sand from falling into the pit. The floor level for the closing and stripping machine should be near the top of the plunger, while that of the cope machine should be about 12 inches below the surface of the stripping plate.

THE SURFACE APPEARANCE OF SOLDERS*

BY C. O. BANNISTER AND H. J. TABOR

SEARCHING through metallurgical and chemical literature, it is surprising to find that very little information has been published on questions relating to the manufacture, properties, methods of analysis, and uses of solders, and the following work has been carried out with a view of testing the varying conditions which affect the surface appearance of solders, and particularly the effect of small quantities of antimony and other metals on solder.

It is well known that sales of solder are often influenced by appearance rather than by chemical analysis, and the following are the chief properties taken into account:—

1. Its appearance. It is generally cast in the form of strips, and particular attention is paid to the nature of the surface as to whether it is white or has a yellowish color, bright or dull, smooth or rough, spotted, pitted or pimply, and whether it has or has not a furrow.

2. Its toughness, and the nature of the fracture.

3. Its hardness.

4. Its melting point.

A good solder, as far as appearance is concerned, should, when in the form of strips, be white, have a furrow running along the center, be smooth and free from rough patches, spots, pits, or pimples, and be free from stippling at the ends.

The following are the conditions which affect the appearance of solders:—

1. Chemical composition.

2. The temperature of the metal when casting.

The surface is generally better when the metal is poured hot, but not too hot. Metal which pours spotty may often be remedied by varying the conditions of pouring, etc.

3. The material of which the mold is made. A bad conductor of heat like marble is generally supposed to give a better surface than one made of a good conductor such as iron.

4. The temperature of the mold; to a certain extent, the slower the metal sets, the better the surface.

5. The thickness of the strips.

6. The use of a cone in pouring or the addition of a little grease or resin.

The first series of experiments were made in order to examine the effect of small quantities of antimony on solder, and at the same time to determine the effect of casting under different conditions.

Preliminary experiments were first carried out with a small iron mold giving a strip of metal 3 inches long, 5/16-inch wide, and ¼-inch thick, and a small marble mold giving a strip 4 inches long, ½-inch wide and ⅜-inch thick. The alloys for these strips were prepared in small crucibles over a bunsen burner. The required amount of antimony was added to the molten lead-tin alloy either as metallic antimony or, in a few cases, as a rich lead-antimony alloy containing 25 per cent antimony.

The metal in each case was covered with resin or charcoal, and analyses were carried out to control the composition of the resulting alloys. These experiments were repeated on a larger scale with full-sized molds in the case of the alloys giving the best surface appearance, the alloys being prepared in a crucible in a wind furnace under charcoal.

*Presented at the annual meeting of the Institute of Metals, Manchester, Eng., October, 1909.

Table I.

EFFECT OF ANTIMONY ON THE APPEARANCE OF SOLDER.

Experiment.	Per cent. Tin .....50 Antimony .... 0 Lead 50	Per cent. Tin .....46 Antimony .... 1 Lead 53	Per cent. Tin .....46 Antimony .... 2 Lead 52	Per cent. Tin .....46 Antimony .... 3 Lead 51	Per cent. Tin .....46 Antimony .... 4 Lead 50	Per cent. Tin .....46 Antimony .... 5 Lead 49
I.—Metal poured at a red heat into hot iron mold and cooled slowly.	Bright crystal line, with rough patches.	Not so bright; crystalline, with large number of rough patches.	Bright, with a certain amount of roughness.	Bright, yellowish color; irregularly dispersed spots.	Dull, yellowish color; smooth, but frosty.	Bright, with deep, irregular cavities.
II.—Metal poured at a moderate temperature into hot iron mold.	Bright and smooth, with furrow.	Bright, smooth, with slight inclination to frostiness.	Smooth and brighter than the alloy containing no Sb.	Smooth, frosty; small clear spots.	Smooth, white, but frosty.	Bright, smooth, with slight development of spots and frostiness.
III.—Metal poured at a slightly higher temperature than in previous case into cool iron mold.	Bright, smooth, with furrow.	Bright and smooth.	Very bright and smooth, with furrow.	Bright and smooth, except for pimpliness along the furrow.	White, smooth, flat, and frosty.	Bright and smooth, except for slight pimpliness along the furrow.
IV.—Metal poured at a moderate temperature on to a cold iron plate.	Fairly bright and smooth.	Fairly bright and smooth, with small amount of roughness.	Bright and smooth.	Not very bright; pimply.	Smooth, frosty surface.	Fairly bright with small pimples.
V.—Metal poured at a moderate temperature into a cold marble mold.	Bright and smooth, with furrow.	Bright and smooth, except for slight frostiness at ends.	Bright and smooth, with furrow.	Frosty, with spots.	Smooth, frosty, with spots.	Bright, with pimples; inclination to frostiness.

The dimensions of these larger strips were:—

(a) In the iron mold: Length, 11 inches; width, ½ inch; thickness, ½ inch.
(b) In the marble mold: Length, 16 inches; width, ½ inch; thickness ⅜ inch.

The following are the details of the experiments carried out on the antimonial solders:—

Experiment I.—The molten alloys were poured at a red heat into a hot iron mold and allowed to cool slowly.

Experiment II.—The alloys were cast at a lower temperature, just sufficient to char a piece of wood, into a hot iron mold.

Experiment III.—The alloys were cast at a slightly higher temperature than that used in Experiment II, but a cool iron mold was used, so that the metal solidified in from 20 to 30 seconds after filling the mold.

Experiment IV.—The alloys were cast at a temperature just sufficient to char a piece of wood, onto a cold iron plate, where they solidified immediately.

Experiment V.—The alloys were cast at a fairly low temperature into a cool marble mold, in which they solidified very soon after filling it.

Mixtures Used.

These experiments, carried out with a series of alloys containing 46 per cent tin and from 1 to 10 per cent antimony, are summarized in Table I; and for comparison an ordinary solder, 50 per cent tin and 50 per cent lead, was also used. The results obtained for the alloys containing up to 5 per cent antimony are summarised in Table I; as the whole of the alloys containing more than this amount of antimony were more or less frosty, rough, spotty, pimply, or crystalline under the conditions used in each of the experiments, these have not been entered. The ingots obtained were nicked, fractured, and the fracture examined. The alloy containing no antimony was tough and gave a silky fracture; the alloys containing antimony were not so tough, and were very finely crystalline, this crystallization slightly increasing with the increase in the amount of antimony. The alloys containing 1 and 2 per cent antimony were fairly tough; the alloy with 3 per cent was inclined to be brittle, and this property gradually increased, until with 7 per cent antimony it was quite brittle.

Comparison of Results.

Comparing the results given in the table, it will be seen that with 1 per cent of antimony the surface is not so good as that obtained with ordinary solder, whereas, with 2 per cent of antimony a surface equal to or better than tinsmith's solder can be obtained.* Increasing the antimony above 2 per cent, roughness, spots, pimples or frostiness is obtained.

The experiments carried out by casting in full-sized molds confirmed the results obtained in the smaller molds; the alloy containing no antimony was not quite equal in appearance to that containing 2 per cent; the furrow in the alloy containing 1 per cent antimony was not very well developed, and with 3 per cent of antimony pimples and spots made their appearance. In some cases the furrow was more pronounced when a marble mold was employed than when an iron mold was used.

The microscopic examination of these alloys throws some light on the effect of antimony when added to solder, for in the case of the alloy containing 3 per cent of antimony, bright cubical crystals are seen on the prepared sections after polishing and etching with hydrochloric acid. These crystals probably consist of the compound SnSb, and as this compound has a lower specific gravity than the bulk of the alloy it rises to the surface. Even in the case of the small strips cast in the marble mold, which solidified very soon after pouring, very distinct segregation of these crystals at the surface was noticed, and there is little doubt that this segregation causes the appearance of spots, etc., on the surface. On the other hand, the alloys containing 1 and 2 per cent of antimony respectively contained no separated crystals of this compound.

Effect of Copper.

In these experiments the solder was made up as before, but with the addition of small quantities of copper, which were added to the molten tin before making up the alloy with lead. The alloys were poured into the small marble mold, the appearance of the surface noted, and then the alloy was fractured, and the strength and nature of the fracture also noted.

It will be noted in Table II that the chief effect of copper in small quantities is to cause blisters and crystallization down the center; in quantities less than 0.6 per cent the surface appearance is not bad, especially if precautions are taken to use the temperature for pouring, most suitable to the composition in question; it was found possible to get very different results by slightly varying the temperature of casting. Above 0.6 or 0.7 per cent the surface appearance was quite inferior, as it became dull, flat and crystalline in addition to having many blisters. It may be mentioned that copper has a much greater effect on the surface appearance of tin than on solder. On fracturing the specimens it was noted that copper hardened the solders, decreased the toughness, and changed the silky fracture into a minutely crystalline one.

*This has already been noted by Parry.

Table II.

EFFECT OF COPPER IN SOLDER MIXTURES.

Copper. Per cent.	Appearance of Surface.
0.1	Fairly bright, with furrow; inclination to form blisters.
0.2	Fairly bright; slight crystallization in the furrow; more blisters.
0.3	Surface slightly dull; crystallization down center; small blisters.
0.4	Fairly bright surface, with good furrow; blisters.
0.5	Fairly bright; crystalline in furrow; large blisters.
0.6	Fairly bright; crystalline in furrow; large blisters.
0.7	Rather dull; crystalline; very little furrow; flat surface; blisters.
0.8	Dull and crystalline; very slight furrow; blisters.
0.9	Dull and crystalline all over; flat, with blisters.
1.0	Dull and crystalline all over; flat, with blisters.

Effect of Silver.

The effect of small quantities of silver on the surface appearance was ascertained, because certain users of large quantities of solder prefer these to be made with lead containing silver. In these experiments, Table III, the silver was alloyed with the lead and then the necessary tin was added, and the solder poured into a marble mold as before.

Table III.

Silver. Per cent.	Surface Appearance.
0.1	Smooth, even, with good furrow, but with peculiar milky white, opalescent effect.
0.2	Smooth, even, with good furrow, but with peculiar milky white, opalescent effect.
0.3	Good surface and furrow, the milky effect becoming more definitely crystalline.
0.4	Surface becomes distinctly white and crystalline, especially in center.
0.5	Surface becomes distinctly white and crystalline, especially in center.
0.6	Surface becomes distinctly white and crystalline, especially in center.

Up to 0.2 per cent of silver a peculiar but by no means unpleasant appearance is given to the solder, which, on increasing the silver, develops into a very white and distinctly crystalline surface, especially about the center of the ingot. These solders were quite tough.

Effect of Zinc.

Extremely minute quantities of zinc were found to be absolutely fatal to the appearance of solders, as will be seen from the following notes:—

Zinc. Per cent.	Surface Appearance.
0.01	Minutely crystalline all over.
0.02	Minutely crystalline all over.
0.1	Very crystalline, with pimples, blisters, and uneven surface.
0.2	Extremely uneven surface.

Besides the very inferior surface appearance obtained on making solders

with zinciferous metals, difficulty was met with in pouring clean from the crucible, a tendency to the formation of skins and skulls being noted.

Effect of Bismuth.

In quantities up to 1 per cent, bismuth was found to have no appreciable effect on the surface appearance of solder.

Conclusions.

1. Solder containing 2 per cent of antimony gives, under proper conditions of casting, a surface which is bright, clear, smooth and superior in appearance to that of the alloy consisting of lead and tin in equal proportions.

2. Solders containing more than 2 per cent of antimony give surfaces which are either rough, spotty, frosty or pimply, but the extent to which these defects are present does not increase in proportion to the amount of antimony added.

3. The surface obtained by casting in marble molds does not seem superior as regards brightness, smoothness or clearness to that obtained in iron molds, but a more clearly defined furrow is generally obtained.

4. Solders containing small quantities of copper give good surfaces, but with a tendency to blister, while larger quantities give dull, flat, crystalline surfaces.

5. Solders containing small quantities of silver have a peculiar white crystalline appearance on the surface.

6. Zinc is a most detrimental metal to have present in solders, as minute traces give very inferior surface appearances.

7. Bismuth in small quantities has no effect on the surface appearance of solders.

How the "Old Man" was Won Over

"Along early in the winter," said the foundry foreman, "they called me over to headquarters, up to the drawing room. The old man was there, studying the blue prints for some new cylinders he had been working out with the chief draftsman. They must have stayed up nights on the job, for the drawings were fancier than anything they'd ever sent to the foundry. The old man went over them with me.

"'Can you get 'em out?' he asked.

"'I can try,' I told him.

'"You can *try?*'" said the chief draftsman. 'Is that all you can do? Anybody can do that much, and we're giving you credit for being a first class foundryman.'

"'Now look here,' I said to him, 'I might tell the president I could get out that casting, and probably I could. But I'd only be guessing about it. I don't know sure. Now, why isn't it a blame sight better for me not to be too everlastingly positive till I'm certain I know what I'm talking about?'

"Then I asked the president to let me tackle the hardest proposition of the lot, and he said to go ahead. Well, the casting turned out bully, smooth and true and without the sign of a flaw. They were as tickled as could be up at the office, particularly the old man, who called me up to talk it over.

"'I guess there isn't much doubt now that you can turn out that cylinder according to the design,' he said.

"'You're satisfied with the casting?' I asked him.

"'Why, yes,' he said. 'Certainly I'm satisfied.'

"'Well then, I'm not,' I told him. 'That's only a trial casting, and you're not counting on using it. Now I want it cut up so that we can see what the cylinder looks like inside. Judging from outward appearances, it's all right, but maybe there's something out of the way that we can't see. It might be a good while before we would discover anything wrong. A lot of these cylinders might have gone out onto the market, and they wouldn't be doing our reputation any good. I want this one cut up so that we will know it's in first class shape inside and out. Then we can go on with the others.'

"The old man thought this was a good idea, and we tried it. We didn't find anything wrong inside the cylinder, but I've noticed that lately they've been calling me up to the office more and more, and from the way the old man talks, I believe he's coming around to the place where he sets some store on what I've got to say about any troublesome little job that turns up."

POCKET DIARY AND YEAR BOOK FOR 1910.

The "Pocket Diary and Year Book for 1910," published by the *Mechanical World*, Manchester, Eng., contains considerable new matter, including an entirely new section on oil engines with notes on crude oil engines by W. A. Tookey, who has also revised the section on gas engines. Condensed notes on the design of centrifugal pumps have been contributed by B. M. Woodhouse, and a new section on ball bearings has been included. Among other additions are the following: Dimensions of marine boilers; tapers and angles; change wheels for cutting metric pitches; hobs for cutting involute gears; dimensions of ring-oiled bearings; emery wheel speeds, etc.

PITTSBURG FOUNDRYMEN'S ASSOCIATION.

The monthly meeting of the Pittsburg Foundrymen's Association was held at the Carnegie Technical Schools on the evening of Oct. 4. Edgar Allan Custer, president of the Tacony Iron Co., Tacony, Philadelphia, Pa., presented an interesting address on permanent molds illustrated with moving pictures showing the operations of a soil pipe and fitting plant, where these permanent molds are in use. A demonstration of the use of permanent molds was given in the laboratory of the technical schools, castings of soil pipe fittings and flanges having been made in four permanent molds.

The Bristol Company, Waterbury, Conn., in bulletin No. 113 describes its line of steel belt lacing, which has been extensively used during the past 20 years. Bulletin No. 112, published by this concern, describes the new lines of Bristol's recording thermometers especially adapted for the lower ranges of temperatures. The various applications of these thermometers in power plants are also outlined.

ELEMENTS OF PATTERN CONSTRUCTION--I

This is the first of a series of articles on pattern shop work in which the simple and difficult problems of the model maker will be discussed

BY JOSEPH S. HORNER

THIS series of articles will treat of the constructional aspects of patterns as distinct from the question of molding, that is, how the patterns should be made in order to possess the maximum strength, and the retention of their shape and dimensions. These problems have to be solved in different ways according to the shape of patterns, whether plain areas, circular, cylindrical, or forms which include these, and whether of large or small dimensions. The latter obviously is a very important consideration.

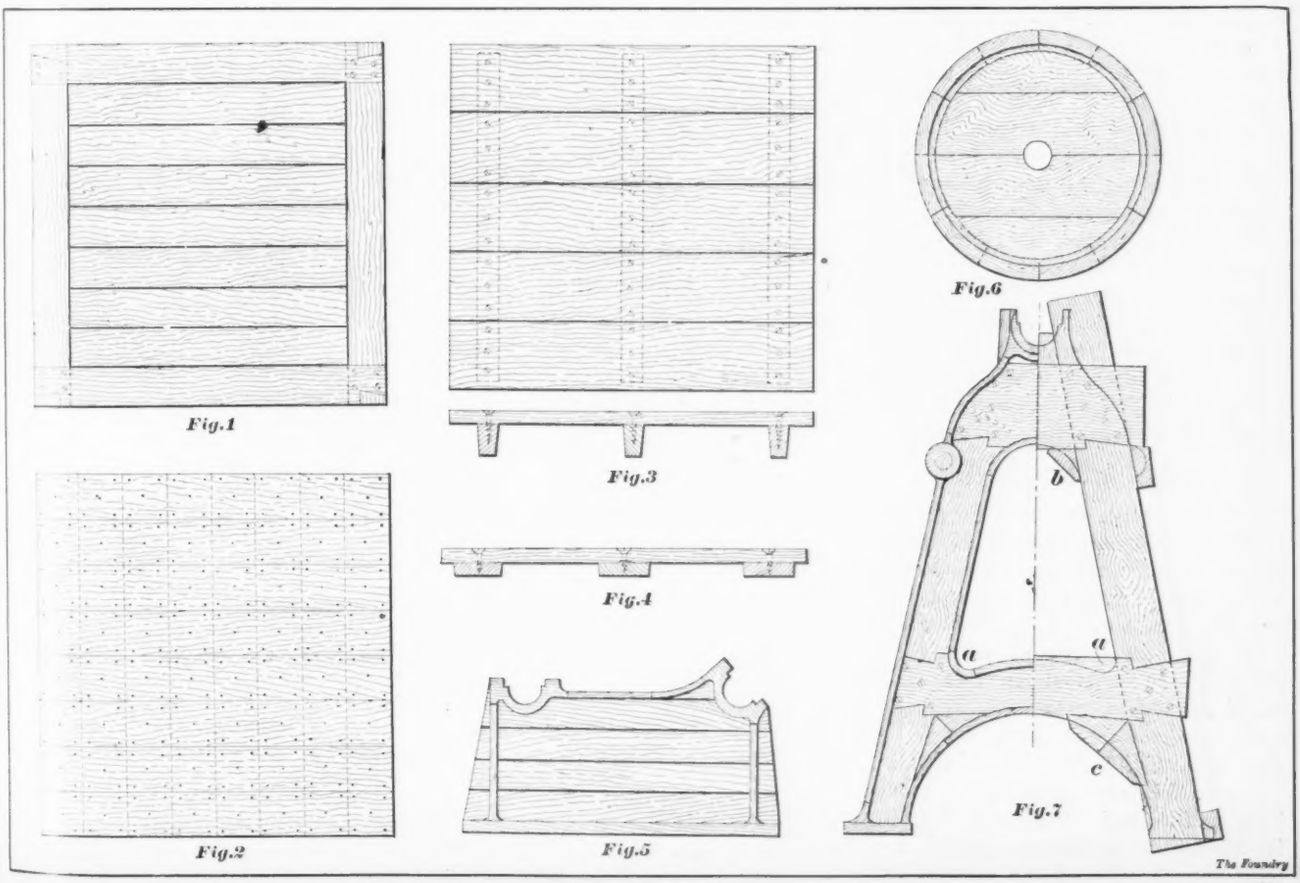
In the first place, the question of how to make a broad area permanent is answered differently according to whether, or in what way the area can be reinforced or supported. A merely plain plate occurs comparatively seldom, but examples occur in the back plates of some molding boxes, the false bottoms of mortar mills, perforated gratings, checkered footplates, and kindred work. A plate will never remain true very long if made solid, either of a single width, or of several widths glued edge to edge. Broad areas are made thus with open joints, but then support has to be afforded to the plate in some way or another.

The best way to make a broad unsupported area is to frame it, Fig. 1, which leaves an open space in the center. This is then either strickled, or loose boards are laid in to ram on, as shown, which would be done if a good many molds were required. Such a plate, though unsupported in any way, and though thin, remains true for an indefinite period.

If a plate is fairly thick, say over 1 or 1½ inches, it may be made solid by crossing two or more thicknesses of material with open joints, Fig. 2. This will not go out of truth. There is then neither strickling, nor loose pieces. But as plain plates are seldom required, flanges, ribs, or segments can generally be attached to plates, with the result of maintaining their strength and truth.

Use of Battens.

The batten is used to a considerable extent across wide pieces and open-jointed work, Figs. 3 and 4. It is an excellent device for maintaining broad pieces true. As a rule it is employed in parts which lie outside the actual mold or core; but it is sometimes so desirable in light flimsy patterns, that it is put on them when its impression will have to be filled or stopped-up. It is a common fitting to the bottoms and sides of core boxes. It is used largely on bottom or joint boards. The deeper the battens are made, the more rigidly they maintain the strips which are attached to them. But an objection to deep battens on pattern parts is that



the vertical bars of the molding boxes would often come in contact with them. Battens, like core prints, are tapered largely when their impressions have to be filled up.

A tank plate is a familiar case of a plate surrounded by comparatively shallow flanges. These plates are generally molded from iron patterns in the regular tank shops, but for single special jobs, wooden patterns are used. These are either framed like Fig. 1, leaving a central open space, or they are made with narrow strips, open-jointed, which are retained together by the flanges crossing them, and screwed on through the strips.

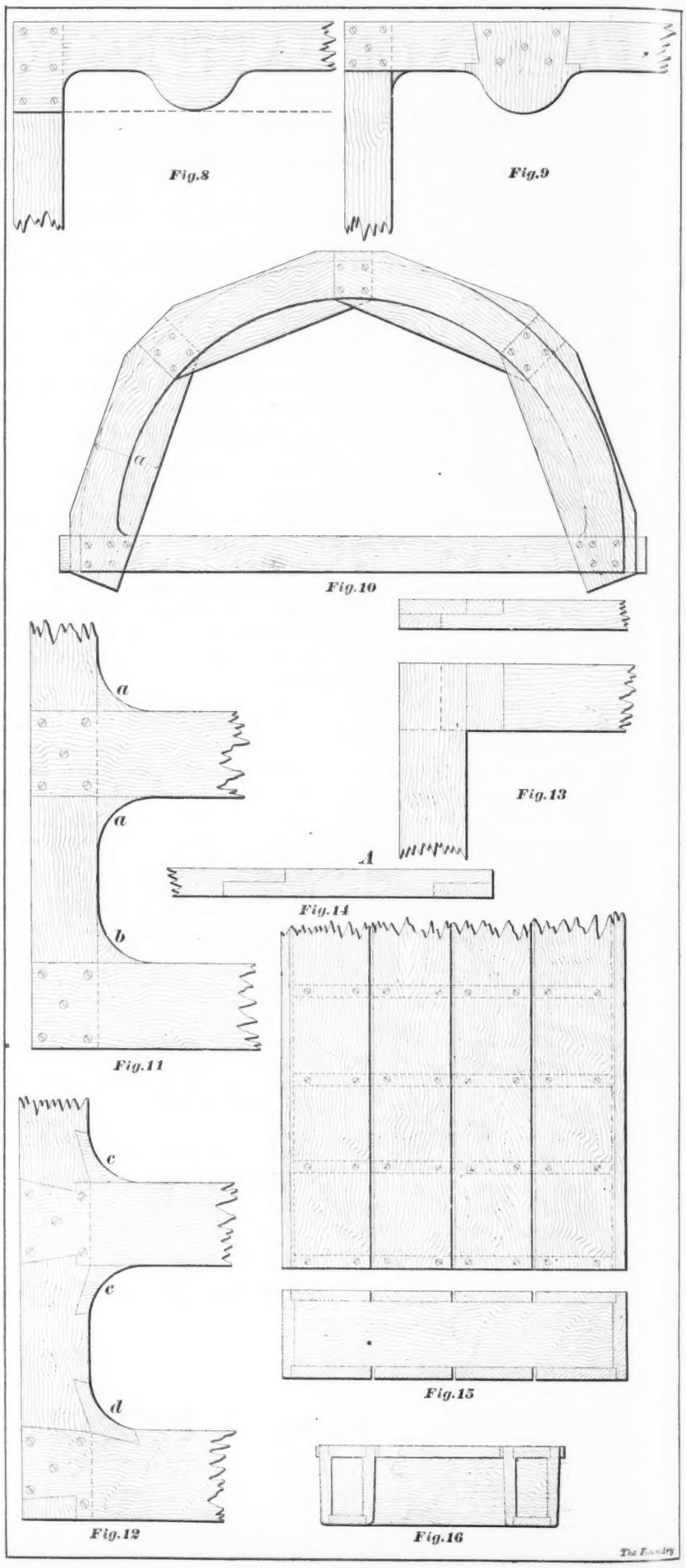
In the foregoing cases the choice of half laps, or open jointing is a matter of indifference. But in most instances the choice settles itself, because in open-jointed work any severance of sections would be weakening. Open-jointed material must be continuous. It is very suitable for all-plated work which is of this description, even though the bounding outlines are of irregular shape. It is thus adopted for numerous crane cheeks and large brackets, the edges of which are surrounded with ribs, and carry bearing blocks and bosses, as in Fig. 5, or in the gear wheel body Fig. 6.

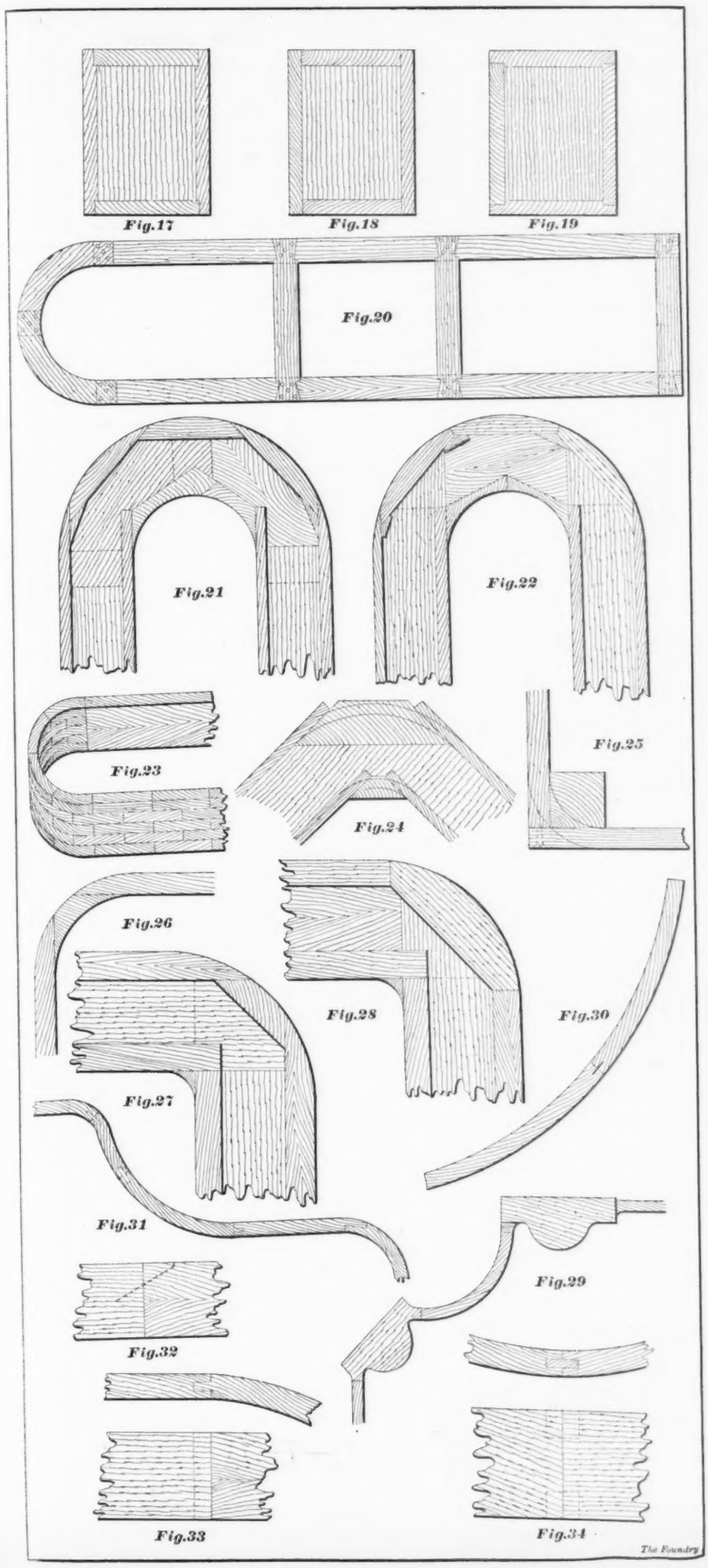
But a pattern for an A-frame cannot be made thus, nor any frame or cheek having large open spaces. It must be framed with half lapping joints, so making material continuous, with the maximum of strength. However irregular the shapes of open frames they can always be constructed in this way. Fig. 7 shows a pattern as it appears halved, but not cut on the right hand side, and finished on the left. There are of course alternative methods of making these halved joints. But the dispositions of the strips must always be arranged with due regard to the maximum strength and minimum of possible shrinkage. Thus, one often sees a very wide halving like Fig. 8, which is bound to shrink in time, when a construction like Fig. 9 is better for permanence.

Division of Patterns.

When there are large curved portions in a pattern, the number of halved pieces should be sufficient to avoid very short grain, Fig. 10. The amount of shrinkage, it must be remembered, is more than the width of the finished material. It is equal to that which would take place on the full width *a*.

Halvings are either plain, Fig. 11, or dovetailed, Fig. 12, the latter being the stronger. The alternative to these would be a mortise and tenon joint, but that is seldom used, because plated patterns are generally too thin to permit of





cutting such joints, but also because the halving is made more quickly. Another reason which exists sometimes is that a halving permits of ready alteration in the dimensions of a pattern, and a tenon does not. A halved piece can be shifted outwards and made good for molding a larger plate, Fig. 13. This is often done in foot-plate work. Or the length of a framed plate can be extended by the insertion of a new piece, as at *A*, Fig. 14.

How to Avoid Shrinkage.

We remarked in connection with Figs. 7, 8, and 9, on the necessity of lessening risks or shrinkage by the fitting of large radii in corners. Figs. 7, 11, and 12 are cases in point. These may be cut in the solid when they are small as at *a*, Fig. 7. But when they are large, as at *b* and *c* they would, if cut from the solid, require wide material, which would certainly shrink in course of time. Hence the reason of their separate fitting. In Fig. 7 the block at *b* is fitted with the grain perpendicular, because if plank-way, the edges would be weak. At *c* the block is fitted plank-way, but the edges are strengthened by letting the block in, in a dovetailed fashion, and short grain is lessened by making the corner piece in two. In Fig. 11 a bad fitting is shown at *a, a*, for the reasons just stated; *b* is suitable, being end grain with strong edges. In Fig. 12, *c, c* shows a method sometimes adopted, but rather liable to shrink; *d* is on the whole the best. Such blocks must in any case be properly glued.

Pattern Thicknesses.

Related to the question of broad areas is that of thicknesses, which are too great to be made of a single board or plank. Generally, when a thickness of 3 or 4 inches is exceeded, a hollow structure will be more permanent than a solid one. Four sides enclose a space, so confining the possible shrinkage to these sides. If the width exceeds say 8 or 10 inches it must be made with strips and open joints, as in a broad plain plate. In order to prevent risk of the flat sides and top being rammed inwards, cross bars have to be fitted at intervals and the sides and top are nailed or screwed to these. Fig. 15 is an example of this kind. Fig. 16 is a section through a boxed-up engine bed.

In boxing up work it is better to make the sides run the entire depth, and let the top and bottom come within them, preferably as in Fig. 17, or with plain abutting joints only, Fig. 18. There is less risk of the sand being dragged up in delivery, as there would be in Fig. 19, if the bottom and top shrank or

swelled, and so came within or beyond the faces of the vertical sides.

Box-Type Patterns.

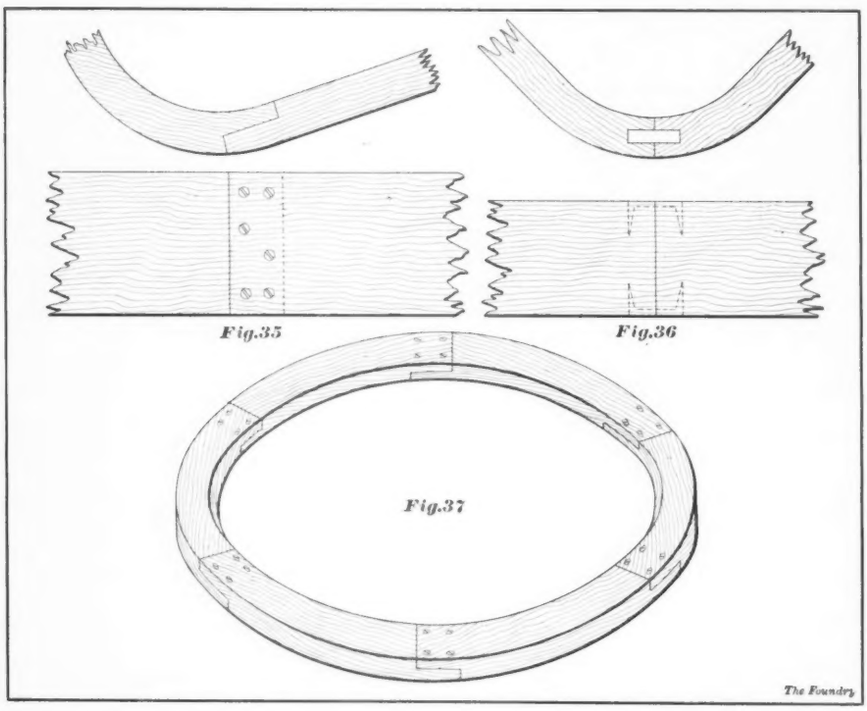
Boxed-up patterns being of many outlines include varied constructions. In some cases the main pieces are continuous forming a main boxed-up rectangle to which required attachments are made. In others it is an open affair, portions being curved. Then a top and bottom, Fig. 20, are properly made with strips, half lap-jointed. These are separated by sundry vertical side pieces to make up the depth, to which the top and bottom are screwed. Curved or semi-circular portions are fitted either as short blocks worked to the sweeps, Figs. 21 and 22 showing alternative methods, or they are built up in segments, Fig. 23, and fitted between top and bottom. Engine beds, various base plates and machine frames afford good examples of work of this kind. All these must be made by boxing-up, otherwise they would not remain true for any length of time. When the interior of a casting is made by coring, the outside only of the sweeped end need be sweeped. As in Figs. 21 and 22, the interior may be straight, or cut roughly to curve by the band saw.

These are large radii. Small ones are made by a single piece of blocking, of which examples are shown in Figs. 24, 25, 26, 27 and 28, for inside and outside curves, and for outside curves only, as in boxed-up work. These require no explanation. In each case the blocks are glued in, and the curves worked when the glue has dried. Screws or nails, put in diagonally, may be inserted after the curves are worked.

Sweeps.

The methods of fitting the ends of sweeped pieces are numerous. Of curved ribs, Fig. 29, there are plenty of all radii occurring, and it is usual to cut them from the solid with band saw, gouge, chisel and spokeshave. They are glued and screwed to the plated portion. A long sweep must be made in more than one length if it is to retain its form permanently, as for instance in Figs. 30 and 31. If the sweep is shallow or not exceeding 2 or 3 inches in depth, a simple butting of the joint is sufficient to prevent lapping of the meeting ends. But if deeper, something more is necessary. A wire nail driven in askew is often enough, Fig. 32. But for permanent standard work a tongue of hoop iron or of wood is often fitted, Fig. 33, passing through the entire depth as shown, or inserted only a little way in from each side as in Fig. 34, or a lapped joint is made, Fig. 35, either method being suitable. Sometimes little dogs are driven in each side, Fig. 36.

Fig. 37 illustrates a method of construction sometimes adopted with large flanges for loam work, and for patterns where glued-up courses of segments would be expensive, or where the glue would be objectionable. Segments in one thickness are fitted with half lap joints, and well screwed.



NORTHWEST FOUNDRY FOREMEN ORGANIZE.

At an enthusiastic meeting held recently at the chamber of commerce, Seattle, Wash., steps were taken to organize an association for educational purposes among the foundry foremen of the Puget Sound district.

George B. James, president of the Variety Iron Works, Seattle, spoke of the great need for such an organization among the foundry foremen. He pointed out the value of the educational work being done by the technical journals and showed how an organization of interested men could, by intimate personal discussions, derive even greater educational benefits.

R. D. Wood, representing the foundry foremen of Tacoma, spoke in favor of the organization and promised the support of the foundrymen of upper Puget Sound. A number of other speakers, among whom were H. W. Sumner, J. H. Linton, H. S. Hastings and A. W. Gregg, made remarks indicating the degree of interest the foundry foremen are taking in the movement.

At the conclusion of the meeting the following provisional organization was formed: President, George James; secretary, H. S. Hastings; committee on constitution and by-laws, R. D. Wood and H. Cole Estep.

MELTING DIFFICULTIES.

By W. J. Keep

Question:—Our cupola is 54 inches in diameter and is lined to 36 inches. A bed of 550 pounds of coke fills the cupola to a point 24 inches above the tuyeres. The iron charges average 1,000 pounds with 90 to 100 pounds of coke between them. The blast is furnished by a pressure blower operated at 2,250 revolutions per minute, and delivering 5,700 cubic feet of air at 9 ounces pressure. The cupola has six tuyeres of a combined area of 300 square inches. We are only able to melt three tons per hour, whereas the cupola is rated from four to six tons.

Answer:—No improvements can be suggested in your operating conditions. However, to melt more rapidly, the coke should be burned at increased speed. Reducing the coke charges slightly, approximately to 80 pounds, would help, and the bed might likewise be reduced about 25 pounds. The clogging of the tuyeres or sharp bends in the wind pipes will also have a tendency to retard the melt. The use of poor coke or careless charging, and the use of large pieces of scrap will also cause trouble. The only way to overcome these difficulties is to employ a good melter.

THE FOUNDRY DATA SHEET, NOVEMBER, 1909.

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication.

Note.—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

TABLE OF EQUIVALENT TEMPERATURES. CENTIGRADE TO FAHRENHEIT.

Rule to change the values: $\text{Fahr.} = \frac{9}{5}\,\text{C} + 32°$.

$$\text{Cent.} = (\text{F} - 32°)\,\frac{5}{9}$$

Degrees, Cent.	Degrees, Fahr.	Degrees, Cent.	Degrees, Fahr.	Degrees, Cent.	Degrees, Fahr.	Degrees, Cent.	Degrees, Fahr.	Degrees, Cent.	Degrees, Fahr.
—10	+14	22	71.6	54	129.2	86	186.8	190	374
— 9	+15.8	23	73.4	55	131	87	188.6	195	383
— 8	+17.6	24	75.2	56	132.8	88	190.4	200	392
— 7	+19.4	25	77	57	134.6	89	192.2	205	401
— 6	+21.2	26	78.8	58	136.4	90	194	210	410
— 5	+23	27	80.6	59	138.2	91	195.8	215	419
— 4	+24.8	28	82.4	60	140	92	197.6	220	428
— 3	+26.6	29	84.2	61	141.8	93	199.4	225	437
— 2	+28.4	30	86	62	143.6	94	201.2	230	446
— 1	+30.2	31	87.8	63	145.4	95	203	235	455
0	+32	32	89.6	64	147.2	96	204.8	240	464
+ 1	33.8	33	91.4	65	149	97	206.6	245	473
2	35.6	34	93.2	66	150.8	98	208.4	250	482
3	37.4	35	95	67	152.6	99	210.2	255	491
4	39.2	36	96.8	68	154.4	100	212	260	500
5	41	37	98.6	69	156.2	105	221	265	509
6	42.8	38	100.4	70	158	110	230	270	518
7	44.6	39	102.2	71	159.8	115	239	275	527
8	46.4	40	104	72	161.6	120	248	280	536
9	48.2	41	105.8	73	163.4	125	257	285	545
10	50	42	107.6	74	165.2	130	266	290	554
11	51.8	43	109.4	75	167	135	275	295	563
12	53.6	44	111.2	76	168.8	140	284	300	572
13	55.4	45	113	77	170.6	145	293	305	581
14	57.2	46	114.8	78	172.4	150	302	310	590
15	59	47	116.6	79	174.2	155	311	315	599
16	60.8	48	118.4	80	176	160	320	320	608
17	62.6	49	120.2	81	177.8	165	329	325	617
18	64.4	50	122	82	179.6	170	338	330	626
19	66.2	51	123.8	83	181.4	175	347	335	635
20	68	52	125.6	84	183.2	180	356	340	644
21	69.8	53	127.4	85	185	185	365	345	653

(*Continued from Data Sheet No.* 53.)

TABLE OF EQUIVALENT TEMPERATURES. CENTIGRADE TO FAHRENHEIT.

Degrees, Cent.	Degrees, Fahr.	Degrees, Cent.	Degrees, Fahr.	Degrees, Cent.	Degrees, Fahr.	Degrees, Cent.	Degrees, Fahr.	Degrees, Cent.	Degrees, Fahr.
350	662	510	950	670	1238	830	1526	990	1814
355	671	515	959	675	1247	835	1535	995	1823
360	680	520	968	680	1256	840	1544	1000	1832
365	689	525	977	685	1265	845	1553	1005	1841
370	698	530	986	690	1274	850	1562	1010	1850
375	707	535	995	695	1283	855	1571	1015	1859
380	716	540	1004	700	1292	860	1580	1020	1868
385	725	545	1013	705	1301	865	1589	1025	1877
390	734	550	1022	710	1310	870	1598	1030	1886
395	743	555	1031	715	1319	875	1607	1035	1895
400	752	560	1040	720	1328	880	1616	1040	1904
405	761	565	1049	725	1337	885	1625	1045	1913
410	770	570	1058	730	1346	890	1634	1050	1922
415	779	575	1067	735	1355	895	1643	1055	1931
420	788	580	1076	740	1364	900	1652	1060	1940
425	797	585	1085	745	1373	905	1661	1065	1949
430	806	590	1094	750	1382	910	1670	1070	1958
435	815	595	1103	755	1391	915	1679	1075	1967
440	824	600	1112	760	1400	920	1688	1080	1976
445	833	605	1121	765	1409	925	1697	1085	1985
450	842	610	1130	770	1418	930	1706	1090	1994
455	851	615	1139	775	1427	935	1715	1095	2003
460	860	620	1148	780	1436	940	1724	1100	2012
465	869	625	1157	785	1445	945	1733	1105	2021
470	878	630	1166	790	1454	950	1742	1110	2030
475	887	635	1175	795	1463	955	1751	1115	2039
480	896	640	1184	800	1472	960	1760	1120	2048
485	905	645	1193	805	1481	965	1769	1125	2057
490	914	650	1202	810	1490	970	1778	1130	2066
495	923	655	1211	815	1499	975	1787	1135	2075
500	932	660	1220	820	1508	980	1796	1140	2084
505	941	665	1229	825	1517	985	1805	1145	2093
								1150	2102

A REPORT ON CAST IRON TEST BARS*

The investigator concludes that the test bar is not to be regarded with too much confidence as indicative of the exact strength of the casting

BY A. F. NAGLE

IN machinery castings as well as in cast pipes, separate bars are cast and subjected to tensile or transverse stress to the breaking point, these results being used as evidence of compliance with the contract specifications. The writer has examined a large number of such test bars for castings used in the Baltimore sewage pumps and here reports the results of this examination and study. Perhaps the most important conclusion is that the test bar is not to be regarded with too much confidence as indicative of the exact strength of the casting.

Table I.

ANALYSIS OF CAST IRON TEST BARS.

BARS USED IN I. P. BED PLATE CAST NOVEMBER 21, 1907, AND I. P. FRAME, CAST NOVEMBER 26, 1907, FOR BALTIMORE SEWAGE PUMPS.

Date cast.	Total carbon, per cent.	Graphitic carbon, per cent.	Combined carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulphur, per cent.	Silicon, per cent.	Tensile strain, pounds per square inch.	Transverse load, pounds per square inch.	Deflection, inches.
Nov. 21, 1907.....	3.580	2.830	0.75	0.79	0.485	0.081	1.59	24,900	2440	0.49
Nov. 26, 1907.....	3.396	2.736	0.66	0.38	0.459	0.124	1.91	22,000	2075	0.40

All transverse bars were nominally 2 x 1 x 24-inch centers. They were cast from two patterns in one mold, made in the same kind of sand as the main casting. The flask was inclined about 30 degrees. There was but one gate for the two bars, with suitable risers. The iron for the bars was poured from a small ladle of iron taken as nearly as possible from the middle of the pour of the main casting. The breaking loads were corrected for varying dimensions of the bars by the formula

$$W' = \frac{Wbd^2}{2},$$

where b and d are the actual dimension, W the actual breaking load, and W' the corrected load of weight. These results are used throughout this paper. The deflections were not corrected.

The tensile bars, 1⅝ x 6 inches, were cast upright in the same mold as the main casting, within 3 or 4 inches thereof, and connected by an upper and lower gate. The tensile bars were turned to 1½ inches diameter and threaded, and the middle portion reduced to 1.129 inches diameter, which is equal to 1 square inch area. Table 1 gives the results of the chemical analysis of the several bars tested.

From Aug. 5, 1907, to April 4, 1908, there were made 67 *single* tensile bars and the same number of pairs of transverse bars, and the average of the latter was used in this record. From April 4 to Dec. 19, 1908, there were made 91 pairs of tensile bars and an equal number of pairs of transverse bars, and each piece of the pair is recorded, instead of the average.

Of these 249 tensile bars and their corresponding transverse bars, 32 sets—26 flat and six round—were rejected for defects due to blow-holes, and four tensile bars were too hard to bear threading, but the companion piece was used in this record.

Of the 217 specimens here recorded, 42 were designated as abnormal, that is, the ratio between the tensile and the transverse bars was either considerably greater or smaller than the average.

By referring to Table II, it will be seen that of the 175 specimens of cast iron running from 20,000 to 30,000 pounds tensile strength, the ratio of tensile to breaking loads is practically 10 to 1 and the deflection 0.45-inch.

Table II.

COMPARISON OF CAST IRON TEST BARS.

Number of specimens.	Limit of breaking load of transverse bars.	Breaking loads, pounds. Transverse.	Tensile.	Deflection, inches.	Ratio of tensile to transverse.
29	2000 to 2200	2065	21,630	0.43	10.47 to 1
36	2200 to 2400	2289	22,940	0.45	10.02 to 1
51	2400 to 2600	2523	24,880	0.47	9.86 to 1
43	2600 to 2800	2756	26,500	0.49	9.61 to 1
16	2800 to 3000	2894	28,460	0.49	9.83 to 1
175	Averages.	2383	23,732	0.45	9.96 to 1

NOTE.—Transverse bars, rough 2 x 1 x 24-inch centers; tensile bars, turned 1.129 inches diameter (1 square inch area).

Comparison of Test Bars.

Table III gives 25 abnormal cases where this average ratio is as high as 12.56 to 1 with a deflection of 0.43 inch; also 17 abnormal cases where this average ratio is as low as 7.91 to 1 with a deflection of 0.44 inch. And yet the average of both normal and abnormal bars was again very nearly 10 to 1—10.07 to 1.

Breaking loads, presumably alike, varied in pairs of transverse bars, and also in pairs of tensile bars, as follows: Out of 65 pairs of flat or transverse bars, 14, or 22 per cent, average variation 18 per cent; 17, or 26 per cent average variation 5.4 per cent; 34, or 52 per cent average variation less than 2 per cent.

Out of 65 pairs of round or tensile bars, 22, or 34 per cent average variation 15 per cent; 20, or 31 per cent average variation 5.5 per cent; 23, or 35 per cent average variation less than 2 per cent; 61 other pairs of flat bars, which had only one companion tensile bar, varied in about the same ratios.

Two special flat bars and two special round bars, cast in one mold, one gate and at one pour, varied as follows: Two flat bars, 12 per cent; two round bars, 7 per cent. In order to get some more definite information on these variations, if possible, I had a pair of transverse and a pair of tensile bars made and cast in the same mold, and while the average ratio of tensile to transverse strength was again nearly 10 to 1, as shown in Table IV, the same type of bars again varied 12 per cent and 7 per cent respectively.

*To be presented at a meeting of the American Society of Mechanical Engineers.

I have no satisfactory explanation for the great variations in these test bars, and we can only accept the fact that mathematical uniformity in strength of cast iron bars is not found in the present state of the art. To anyone questioning the results I can only say from my own knowledge of the circumstances that the personal equation did not enter into them.

Careful observation of broken bars did not show that the so-called "skin of the metal" was of any appreciable thickness, and the metal was remarkably homogeneous throughout. The tensile bars being turned, the skin, if there were any, of course disappeared. It is my opinion that the skin adds practically nothing to the strength in either transverse or tensile bars, other causes, though obscure, producing far greater deviations.

Table III.

COMPARISON OF CAST IRON TEST BARS.

ABNORMAL RESULTS.

Number of specimens.	Limit of breaking load of transverse bars.	Breaking loads, pounds. Transverse.	Tensile.	Deflection, inches.	Ratio of tensile to transverse.
		ABOVE 10 TO 1 RATIO.			
10	2000 to 2200	2088	27,143	0.41	12.95 to 1
10	2200 to 2400	2294	28,530	0.43	12.43 to 1
4	2400 to 2600	2436	29,600	0.49	12.15 to 1
0	2600 to 2800	00	00	....	.....
1	2800 to 3000	2890	34,000	0.45	11.76 to 1
25	Averages.	2258	28,365	0.43	12.56 to 1
		BELOW 10 TO 1 RATIO.			
1	2000 to 2200	2105	17,600	0.50	8.36 to 1
4	2200 to 2400	2359	18,825	0.41	7.98 to 1
7	2400 to 2600	2487	18,814	0.43	7.57 to 1
3	2600 to 2800	2656	21 230	0.45	8.00 to 1
2	2800 to 3000	2969	24,500	0.47	8.25 to 1
17	Averages.	2521	19,954	0.44	7.91 to 1

Casting Defects.

Although many castings were condemned for physical defects, such as blow-holes, shrink-holes, sand-washes, and shifting of cores, not a single case of cold-shut was discovered. This is in marked contrast with the writer's experience on similar work in other foundries. Excepting a number of steam valves, which were of iron too soft for their purpose, but one large casting, a discharge air chamber weighing 16,000 pounds, was condemned for being of unsatisfactory iron. In this case the iron was coarse grained and brittle, and was required to stand at least 23,000 to 24,000 pounds. To remove all doubt that the test bars were truly representative of the iron in the main casting, two tensile bars were cut out of a large flange, which had been at the bottom of the mold. These, from the most favored part of the casting, as will be seen, stood but about 17,350 pounds; 90 per cent of that revealed by the test bars. In this case there was a remarkable agreement among these pairs of bars.

It may be interesting to apply these results to the formula for the strength of cast iron beams subjected to similar stress. The commonly used formula† is

$$R = \frac{3Pl}{2bd^2}$$

where R is called the modulus of rupture, or stress per square inch of extreme fiber.

P = load at center.

l = length in inches between supports.

b and d = breadth and depth, respectively in inches.

Making the proper substitutions, we have

$$R = \frac{3 \times 2380 \times 24}{2 \times 2 \times 1 \times 1},$$

or R = 42,840 pounds. This is not the correct figure, however, for the extreme fiber stress; we know this cannot exceed the tensile strength, which we have found to be 23,732 pounds.

I think it is better to use D. K. Clark's formula, given on page 507 of his *Engineers' Tables*, etc.,

$$S = \frac{Wl}{1.155\ bd^2},$$

where S = extreme fiber stress, or tensile strength. If we use the tensile strength found in these tests as 23,732 pounds, the breaking load W would become

$$\frac{23{,}732 \times 1.155 \times 2 \times 1}{24} = 2{,}284 \text{ pounds},$$

the actual breaking load being 2,383 pounds. As this is within 4.3 per cent of the average found in these tests, this formula, using the tensile strength for the extreme fiber stress, seems to me to be more intelligible and dispenses with the "co-efficient of rupture."

†Kent, page 268.

"Mr. Barlow found by experiment that for 1-inch square bars of cast iron, the breaking weight in tons [2,240 pounds, I presume] was expressed by the formula

$$W = \frac{bd^2}{l} \times 13.6,$$

and Robert Stephenson arrived by experiment at exactly the same co-efficient."‡

If we should substitute the value for W found in these tests we would have W, or $\frac{2383}{2240}$, = 1.064 tons = $\frac{2 \times 1}{24} \times$ a constant, or, constant = 12.77, which is within 7 per cent of the co-efficients found by Barlow and Stephenson.

Circular Test Bars.

Since the foregoing was written I have had the opportunity to observe two circular test bars nominally 1¼ inches in diameter by 15 inches long, with 12-inch centers. These bars were cast from two patterns in one vertical dry sand mold and poured from a small ladle, first one and then the other, with the results shown in Table VI.

The tensile bars were taken from the bottom end of the broken test bar, but I do not know whether H or X was poured first. The first tensile bar H had a small air hole, which being corrected for added 7 per cent to its tensile strength, and this is also given in the table. A second bar was then turned up from the immediate joining piece with the result recorded first in the table. The turned bars were 0.937 inch in diameter. Column six gives the original diameter. Column two was found by reducing the actual breaking loads in the ratio of the cubes of the diameters, and column three was reduced to the square inch area. Why the transverse breaking loads should vary 10 per cent and the tensile bars 4 to 7 per cent the opposite way, a total variation of 14 to 17 per cent, I leave to the reflection of the reader. If we apply Clark's formula for the breaking weights for circular bars,

$$W = \frac{0.7854 \times d^3 \times S}{l}$$

we find the values given in column five.

In this age of economic production, the cost of these turned tensile bars is

Table IV.

COMPARISON OF CAST IRON TEST BARS.

SPECIAL, TWO SETS CAST IN SAME MOLD AT SAME TIME.

Number of specimens.	Limit of breaking load of transverse bars.	Breaking loads, pounds. Transverse.	Tensile.	Deflection, inches.	Ratio of tensile to transverse.
1	.....	2350	23,000	0.50	9.79 to 1
1	.....	2100	21,470	0.45	10.21 to 1
2	Average.	2225	22,235	0.47	10.04 to 1
217	All averages.	2380	23,970	0.45	10.07 to 1

‡Clark, page 561.

frequently objected to by the manufacturer. While blow-holes seem to be more frequent in flat transverse bars than in round attached tensile bars, the latter seem liable to a greater abnormal hardness, for which I have no explanation. Some indication of the toughness of cast iron can be seen in its deflection, which is not revealed in a direct tensile pull. I should, therefore, be satisfied with two or three transverse test bars 2 x 1 x 24-inch centers, and a deflection record poured, as near as may be, from the middle of the pour of the main casting, as giving a fair indication of the iron in the main casting, but mathematical exactness cannot be looked for as yet.

If we wish to know approximately the corresponding tensile strength of the iron, we can multiply the breaking load of the 2 x 1 x 24-inch flat bar by 10. If the test bar is of 1¼-inch diameter by 12-inch centers, its breaking load should be multiplied by 8, to obtain the approximate tensile strength. The general rule seems to be, that where both flat bars agree in breaking loads, the tensile strength is 10 to 1 of the breaking load, but where they differ, the 10 to 1 ratio does not hold. A better practice, therefore, might be to cast three round transverse bars and accept the two that agree, if each is round, as a fair sample of the iron, dispensing with the tensile bars. This concession to the manufacturer, I believe, would entail not only no loss to the city's interests, but a positive gain.

Table V.

TEST BARS FROM CONDEMNED CASTING.

Breaking loads, pounds. Transverse.	Tensile.	Deflection, inches.
1,968	19,800	0.35
2,019	19,000	0.50
	Cut out of flange.	
	17,000	
	17,700	

Table VI.

CIRCULAR TEST BARS CAST IN VERTICAL DRY-SAND MOLD.

Bar mark.	—Breaking loads, pounds.— Transverse.	Tensile.	Deflection, inches.	Value of *W* by formula, pounds.	Original diameter, inches.
H	3344	23,070	0.15	2948	1.305
H	3344	23,754	0.15	3036	1.305
X	3026	24,670	0.12	3153	1.300
1	2	3	4	5	6

THE JOLT RAMMING MOLDING MACHINE*

BY E. H. MUMFORD

IT IS now practically 20 years since jolt ramming molding machines, then cam-lifted and dropped on a rigid anvil, were used exclusively for ramming such work as wagon axle boxes and pipe balls. Gradually, the application of pneumatic lifting plungers broadened out through the application of this method to larger work, until today we have pneumatic jolt ramming molding machines in successful service with lifting capacities from 10 to 15 tons and tables 6 x 9 feet, or even larger.

Effect of Ramming.

The method of ramming the sand in jolt ramming operations has the same effect as the old method of squeezing or press ramming, in which the separate particles of silica or quartz, more or less thoroughly coated with bonding element of alumina or clay, are brought into closer contact amounting to a compression of 25 to 30 per cent in volume, and through their closer association, are stuck together by their clay jackets, thus constituting a more or less firm body of rammed sand. Sand has been rammed by impact even before it was rammed by pressure. Throwing sand into the deep pockets of grate bars was practiced long years before molding machines were used, and later we have had what are known as gravity machines, which drop compacted bodies of green sand from an elevation, and which in falling, amalgamate with the sand already dropped into the flask to form a rammed mold. The various processes of securing impact between the particles of green sand and so ramming them are, in fact, embodied in the jolt ramming operation with this advantage; the sand which is to be rammed is placed in proper position with the facing next to the pattern, gaggered and secured as desired, and with the flask full, and with evenly distributed pressure is then rammed by impact of the separate particles, one upon another, through the succeeding blows of the machine table with the mold upon it. This action is not a uniform or simultaneous one, but is rather a progressive operation, and it should be realized that one law applies in relation to all jolt ramming machines, namely, that the effect of the impact, as felt at the table of the machine, varies directly as the height of drop and inversely as the depression of the anvil under the blow. This amount of impact force represents the limit that can be secured with any given machine, and as every part of the horizontal pattern or joint surface shares this principle, it is probable that the first layers of sand immediately in contact with these surfaces, are rammed to a maximum hardness at the very first blow.

What is true of the machine under the depression of the anvil at each blow, is true of each grain or layer of sand as it comes to rest on the sand below it, and the sand in the upper regions of the mold, where it is most remote from the pattern or joint surfaces, is but little rammed by the first impact, but gradually hardens in the lower strata, and the hardness builds back to the upper layers of sand until the entire mold is sufficiently rammed.

Quality of Sand.

The amount of lateral dispersion, such as will allow the sand to adhere to the sides of the flask and pattern and bars slightly tapering, varies with the quality of the sand, and it is noticeable that such sand as used for dry sand molds for steel castings, is better in this way by reason of its lesser friction among its particles, so that its movement down the sides of bars and flasks, and into undercuts, is better than in ordinary green sand. It is preferable to use bars of such a shape that the sand will flow of its own accord in its advance down the sides of the bars without lifting them, so that when the mold is rammed the sand, which has run down the sides of the wedge-shaped bars will be found compacted under their relatively sharp edges and still adhering to their sides.

*Presented at the October meeting of the Philadelphia Foundrymen's Association.

It will be evident from the consideration of these conditions, involving stability and firmness of surfaces, that vibration of all surfaces is to be avoided. Jolt ramming machines practically eliminate the operation of ramming as a time element. Even the heaviest molds placed upon these machines are completely and almost perfectly rammed. When, as in this case, an expensive operation has been reduced to a matter of no importance, other operations which the machine does not perform, rise into unusual prominence, and it is a problem as to the best method of taking advantage of the great economies of jolt ramming machines. It is almost impracticable, with existing foundry appliances, to transport the molds to and from the machines and finish them on the floor fast enough to make complete use of the machine.

The traveling crane is an ideal device for the transportation of these molds. However, if the traveling crane is sent on too many errands, and is made to do the work of transportation which could as well be performed by a surface car, it is soon discovered that its proper function of lifting and lowering is sacrificed to getting hither and thither over the foundry floor, frequently interfering with other cranes on the same runway.

My main purpose in delivering this address is to get more minds at the problem of how to adapt our foundry methods to this new principle of jolt ramming green sand molds, and I make this suggestion, which seems to be the best way to reduce crane service and facilitate what is mainly transportation, thereby getting the best results from jolt ramming.

Mold Conveying System.

We will assume that the machine is stationed at a point on a longitudinal foundry track upon which a number of cars that can pass at turn tables or otherwise are operated. Place this track at one side of the heavy work floor, and, at right angles to this track, flush with the rails upon the floor of the car, bed rails in the floor running across the shop to receive sliding or secondary cars carrying molds prepared on the floor for ramming and standing either upon the rails direct or upon the secondary cars, which will transfer them across the shop to the car on the longitudinal track. The mold is carried to a jib crane serving the molding machine by which the prepared mold is set upon the machine table. After being rammed, it is immediately set back upon the car which brought it to the machine. It is then returned over the route it traveled before, to its original station on the floor. In this way large molds may be rammed on a machine at one point and stored preparatory to pouring on the main floor of the foundry. The problem of handling a large volume of heavy sand, and flasks to and from jolt ramming machines, which are necessarily stationary, can be solved, it seems to me, in no better way than the above. There is no cheaper way to handle the sand to form a mold than in that mold itself.

SCRAPS FROM THE PATTERN SHOP

BY A. B. SAW

THERE are many short cuts in the pattern shop that will frequently, not only effect a great saving in labor, but in the amount of material used as well. When gluing segments for flanges, six segments to a course, and if three courses are required, 18 joints must be glued together, all of which must be faced either on a lathe or planer. The time required to plane down the 1-inch stock to make thin segments involves an unnecessary expense for labor, to say nothing about the amount of material required.

Gluing Segments.

The foreman of a large valve shop in the east, where the writer chased the broom and got his first trade marks, had one of the apprentice boys make a number of pieces as shown at *A*, Fig. 1. The stock was faced and run through the thickness planer, and a card board template was made for each size of flange. The segments were cut out on the band saw and the tongue and groove ends were run through on an ordinary rip saw. These were then glued together three at a time, as shown at *B*, Fig. 1. After the glue had set 3-16-inch wood dowels were driven through the joints at C, thus holding the tongue securely in place. They were then faced off to the required thickness and rounded off on the band saw to the sizes wanted.

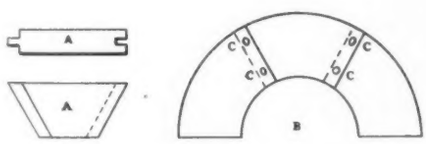


FIG. 1—METHOD OF GLUING SEGMENTS

Patternmaker's Cabinet.

"A place for everything and everything in its place", is a good rule for the pattern shop. The cabinet shown in Fig. 2 will prove very handy, as it is amply provided with shelves and drawers for supplies such as the patternmaker requires in his work. The cabinet is about 4 feet wide, 7 feet high and 1 foot deep, the upper half being partitioned off for drawers having fronts, 6 inches square. The drawer proper, however is only 5½ inches square which leaves a ¼-inch lip extending around the front of the drawer. Knobs are screwed in the center of each drawer and they should be lettered to indicate the length and size of screws or nails that they contain. The lower half of the cabinet should be provided with three or four shelves on each side for stock screws, etc. Two drawers, 4 feet wide and 5 inches high, should be provided for wood dowel pins and leather fillets, while two additional drawers, 1 foot square, are placed side by side at the right of the cabinet. The sides of the drawers are grooved and corresponding pieces are screwed inside the cabinet upon which the drawers slide. As the lower part of the cabinet is provided with hinged doors, knobs or handles on these lower drawers would prevent the closing of the doors, and therefore, two 1-inch holes are bored into each part near the ends. Six shelves, 4 inches high and 12 inches wide, are set into the cabinet at the left for sand paper.

Individual Nail Holder.

The individual nail holder shown in Fig. 3 will prove another time saver in the foundry. A piece of lumber is turned up in halves, 3

inches wide and 13 inches long. One half is cut out making a shell, ¼ inch thick. Quarter-inch strips are placed on the two sides and at the ends, and the partitions are glued in place giving them a slight draft. A small fillet is run around this partition to give the pattern a finished appearance, and also to make it easier to mold. At the end, as shown in Fig. 3, is attached a piece to give the holder a bearing when screwed under the bench. The pattern is then cast in gray iron and each patternmaker should be provided with one of these nail holders.

What to Do in the Pattern Shop.

We have frequently been told what not to do in the pattern shop. Here are a few things that should be done:

Glue up all of your stock when beginning a job.

Put a block on the bench to set the glue pot on.

Keep the hand clamps away from the work as the glue will crack the threads.

Leave the handle of your trimmer up straight. It will make friends if you do—enemies if you don't.

Keep your tools sharp.

Keep your drawings clean. If they are small, tack them on a board with strips of wood.

Wipe your oilstone when your day's work is done.

Pull nails out of pieces of wood before throwing them away.

Make an estimate of your work before commencing and see how it tallies with the actual amount.

Let the foreman first suggest his ideas about a job.

Think twice before asking the foreman questions.

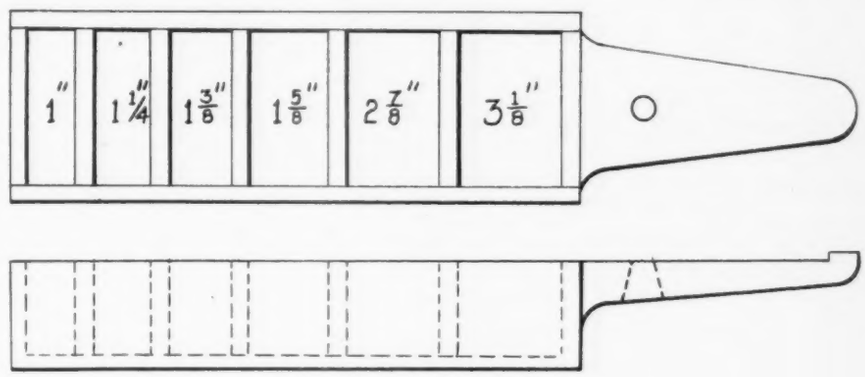


FIG. 3—AN INDIVIDUAL NAIL HOLDER

Go over your layout twice before working to it.

Keep your eye on your work; the boss will take care of himself.

AN ASSOCIATION OF FRENCH FOUNDRYMEN.

At a meeting held Sept. 7, at the Hotel de Ville, Nancy, France, the French Foundrymen's Association was organized. The meeting was largely attended and many letters and telegrams from men prominent in the industry who were unable to attend were read, including one from Dr. Richard Moldenke, secretary-treasurer of the American Foundrymen's Association. The society was organized by the election of M. Masson as president and M. Didier, secretary. Papers were read as follows: "The Electro-Metallurgy of Steel," by M. Brasseur, engineer-in-chief of the Electrical Steel Works of Dommeldange; "The Prevention of Accidents in Foundries," by E. Tholiere, engineer and chief inspector of the Association of Industries of France; "Foreign Foundry Associations," by E. Ronceray, and "Metallic Alloys," by Gaston Auscher.

This meeting was unique in that it was the first gathering of the exclusively technical branch of the foundry industry in France, and the objects of the society were defined as follows:

"The association is founded for the purpose of advancing the art and science of founding to the exclusion of all other phases of the subject, either commercial or professional, which lie within the domain of syndicates and associations now existing."

After adjournment the first day, the delegates visited the laboratory of the Chemical Institute at Nancy, which is one of the best equipped trade schools in France. On the following day the foundrymen visited the metallurgical palace at the Exposition of the East of France.

FIG. 2—A PATTERNMAKER'S CABINET

In a 4-page circular recently issued by Baldwin, Tuthill & Bolton, Grand Rapids, Mich., manufacturers of all steel self-releasing snap flasks for bench or machine molding, extracts from a large number of testimonial letters are reproduced. These communications indicate that there is a large number of satisfied users of these flasks who have purchased them in large quantities. A bench flask outfit as furnished by this concern comprises a cope, drag and six jackets.

MEETING OF THE INSTITUTE OF METALS

Report of the autumn conference of this organization held at Manchester, England--Non-ferrous metals scientifically discussed

BY J. HORTON, Staff Correspondent

THE Institute of Metals held its second autumn conference at Manchester, Eng., on Thursday and Friday, Oct. 14 and 15, the business session being held at the Municipal School of Technology. At the opening meeting Dr. H. C. H. Carpenter, chairman of the reception committee, tendered the visiting members of the Institute a hearty welcome. In the absence of the lord mayor, Councilor T. C. Abbott gave the members a civic welcome to the city. He was followed by J. H. Reynolds, principal of the School of Technology. The addresses of welcome were responded to by Sir Wm. White, president of the Institute. Although having been organized only 20 months, he stated that the organization at present has a membership of 500, a record which he believed is, for such a period of existence, unparalleled in the history of any other technical society.

Aluminum-Copper-Tin Alloys.

"The Constitution and Properties of Aluminum-Copper-Tin Alloys," prepared by C. A. Edwards and J. H. Andrews, was read by the latter. This paper was briefly as follows:

In the metallurgy of non-ferrous alloys, complex mixtures are frequently dealt with. These have been arrived at by the unsatisfactory method of trial and failure, and as a consequence, possess in a more or less degree, the required properties for their particular purposes. This method of working along empirical lines was inevitable up to a comparatively recent date, as many of the alloys were in use long before their application to the laws of physical chemistry. As regards the simple binary alloys, those containing only two elements, the changes of properties, which accompany a variation in composition and heat treatment can be understood by a reference to the equilibrium diagrams of their respective systems. In this regard science is parallel with practice. Of the alloys containing more than two elements, little is known and in the absence of such knowledge, it cannot be said that the ternary alloys in use are the best mixtures of their components. The constitution of the ternary system is graphically represented by an equilateral triangle each corner of which represents one of the three metals. The three sides correspond to the binary mixtures. Any point inside of the diagram indicates a certain mixture of the three. The length of the lines drawn at right angles from each side to a common point inside the triangle, is proportional to the percentage composition of the metal represented at the opposite corner. With the triangle diagram it is possible, however, only to indicate variations of composition. To represent temperature a new axis should be taken, perpendicular to the plane of the triangle. In order to clearly present the method the writers used a hypothetical case taken from "Metal Alloys," in which "a single binary compound is formed, the compound and the three metals show complete mutual solubility when just liquid, and partial solubility when just solid."

This paper was discussed at length by C. H. Desch, and Prof. A. K. Huntington stated that in making prolonged experiments with alloys suspended in sea water, he found that those of aluminum and copper lost less in weight than any of the others. One of 10 per cent aluminum and 90 per cent copper when placed in contact with all of the other metals with which he had experimented lost no weight whatever. Mr. Edwards in the course of his reply said, that with pure aluminum forming an alloy with 20 per cent of tin, no corrosion would take place, providing the alloy was cooled very slowly after casting.

Solders.

"The Surface Appearance of Solders," by C. O. Bannister and H. J. Tabor, was next presented and is published elsewhere in this issue. This was followed by a paper entitled "Notes on Some Probable Causes of the Corrosion of Copper and Brass," by E. L. Rhead.

This paper dealt with the decay of Muntz metal sheathing, bolts and the underwater fittings of ships, the deterioration of brazing alloys in copper pipes, the corrosion of steamship propellers, as well as the corrosion of copper sometimes noted on articles built up from sheet copper and subjected to the action of fire gases.

In the discussion of this paper it was stated that experience pointed to the more rapid corrosion of hard metal as compared with annealed metal. Unannealed copper sheets, it was stated, when used as ship's sheathing were cracked within a few weeks. The nature of the corrosion is peculiar, both copper and zinc being removed while the residue remaining retains its original ingredients in correct proportions. This was contrary to the experience with Muntz metal in which the zinc was removed entirely. It was further added that Muntz metal, when made of the purest metals was more liable to electrolytic dissolution than when made of impure metals.

In the afternoon a visit was paid to the Victoria University and a set of castings were displayed by Mr. Rhead intended for apparatus used in experiments with fluids at exceptional pressures, which interested foundrymen greatly. These castings were successfully subjected to hydraulic pressures of 36,000 pounds to the square inch. For the present at least the contents of the mixture of the metal in these castings is a secret.

Copper-Zinc Alloys.

"The Copper-Zinc Alloys—A Study of Volume Changes," by Prof. Thomas Turner and M. Thornton Murray, was the first paper presented at the Friday morning session. This paper was briefly as follows:

The brass founder, in selecting the composition of a mixture for a certain casting, must consider several points. The brass should be of such a nature as to insure a sound casting; it must not contract too rapidly at the moment of solidification and should "fill the mold;" its co-efficient of expansion and contraction when in the solid state must not be too high, or in the case of complicated patterns, strains will be set up which will tend to produce weakness, if not actual fracture, on cooling. The ultimate shrinkage of brass is also of importance to pattern-makers, since this must be taken into consideration when making castings. This quality, however, in many cases, would be of little use, as an alloy giving a very low ultimate shrinkage might have expanded at one period to such an extent as to destroy its utility for complicated castings.

Throughout the research the investigators bore in mind that an alloy, to be of practical use as a casting metal, must have a fairly high tensile strength and elastic limit, and must, at the same time, be reasonably cheap. The series of copper-zinc alloys was chosen

for these experiments, first, because it is probably the best known and most useful series of non-ferrous alloys; second, the alloys are easily made and the constituent metals are easily obtained in a relatively high state of purity; third, the equilibrium diagram of the series setting forth the various changes taking place at different temperatures have been fully drawn up and verified.

Conclusion.

A summary of the results of the investigation follows:

1. Of the common metals in the pure state, a few (among them antimony, zinc, and aluminum) expand on solidification. Others (including lead, tin, copper, and bismuth) do not expand on solidification. All these metals, after total solidification, contract in the mold at a uniformly decreasing rate until they reach the temperature of the air.

2. Of the brasses, where a simple solid solution exists, the curve of maximum expansion follows the "solidus," when the "liquidus" curve is taken as the base line. So far as the authors have gone in other directions, this law is borne out for all alloys. In the brasses, minima on the expansion curve occur at 100 per cent copper, 60 per cent copper, and 40 per cent copper, while the curve descends to a low figure at 9 per cent copper, and falls very little from there to 0 per cent copper. Maxima appear at about 80 per cent copper (large), 50 per cent copper (small), and 14.76 per cent copper (extraordinarily large).

3. The total shrinkage of the brasses, (first investigated by Turner and Simpson, and confirmed by the present authors), show minima at about 72 per cent copper, 58 per cent copper, and somewhat below 20 per cent copper, while maxima appear at 65 per cent copper and 40 per cent copper, of which the maximum at 40 per cent copper is the greater.

4. The hardness curve of the brasses by both scleroscope and Brinell methods, gives maxima at 78-80 per cent copper, 55 per cent copper, 40 per cent copper (very great), and 9 per cent copper. Minima are at 100 per cent copper, 70 per cent copper, 52 per cent copper, 15 per cent copper, and 0 per cent copper.

5. Finally, with regard to the brasses, the experiments carried out have led the authors to a result similar to that arrived at by W. Guertler, that a compound exists at 40 per cent or, more accurately, 39.36 per cent copper, and 60.64 per cent zinc, the alloy of this composition being called a solid solution.

Shrinkage.

Appended to this paper were notes on shrinkage by Prof. Thomas Turner, in which he stated that he was consulted by a firm of brass founders that was frequently troubled by grids and similar castings cracking in the molds. He assumed that the thin parts contracted more than the heavy sections, and suggested that wherever possible, uniform sections should be used. The change led to better results, but the advice, he admitted, was based on a false assumption. Actual experiments at this foundry, and confirmed in his laboratory, showed that thin copper or brass castings do not contract more than those of heavier section, and in some instances the opposite is the case. Tests by Simpson, confirmed by Murray, show that in the copper-zinc alloys, with from 100 per cent copper to about 70 per cent zinc, thick and thin patterns behave exactly alike. In other words, there is no chilling effect due to rapid cooling. The same is true with about 60 per cent of copper and also with 40 to 10 per cent. On the other hand, alloys in the neighborhood of 65 per cent copper, and also those with about 50 per cent copper, shrink less in thin bars than in thick ones, or in other words, behave in a manner which is exactly opposite to that of cast iron.

Physical Tests of Non-Ferrous Metals.

A paper entitled "The Elastic Breakdown of Non-Ferrous Metals," was presented by C. A. M. Smith, assistant professor of engineering, East London College. An abstract of the paper follows:

The experiments noted in the paper were made to inquire into the failure of the materials used in engineering work. After the conclusion of tests on mild steel, it was decided to repeat and compare them with similar tests on non-ferrous metals. The investigations included tension and compression tests made in an instrument called the sphingometer. Various tests on the effect of overstrain and slight heat treatment on non-ferrous materials were given, and the results compared with similar tests upon mild steel.

The last two papers read included "Notes on the Production of Pure Spelter," by J. S. G. Primrose, and "The Technical Assay of Zinc," by H. W. Greenwald and F. J. Brislee.

Early History of Brass.

Prof. Gowland presented some interesting data regarding the early history of brass. He stated that the first brass that he had been able to find was a Roman coin made 20 B. C., and from that time and for about 200 years, the Romans made brass coins containing from 75 to 80 per cent copper, the remainder of the mixture consisting of zinc without tin. Ornamental brass work was also made, and brass was used in the manufacture of what was erroneously described as bronze armor. Some time ago, he added, a suit of scale armor was found, which, upon examination, was found to be made up of a mixture of 80 per cent copper and 20 per cent zinc. He added that recent investigations showed that brass articles supposed to have been made by prehistoric people, undoubtedly were made in post-Roman times, and from their analysis they were evidently produced by melting Roman coins. In making this brass, Romans melted the copper together with the zinc ore, as this existed in large quantities in northern Italy. This method of making brass remained in use in Birmngham, Eng., at one plant until very late in the 50's, and the brass thus made was sold as calamine brass.

At the close of the conference the president announced that the next meeting would be held in London in January. He also referred to the nomination of Sir Gerard Muntz as president for the ensuing year, the annual election being held in January.

The members of the institute visited a number of works, including the plants of the British Westinghouse Electric & Mfg. Co., Ltd.; Baxendale & Co.; Isaac Storey & Sons, coppersmiths and brass founders; Richard Johnson & Nephew, Ltd., wire manufacturers, and James Smith & Sons. Many also availed themselves of the opportunity to visit the Manchester ship canal, which is an inland waterway 35½ miles long, by the construction of which Manchester was practically made a seaport town.

BRITISH FOUNDRYMEN'S WINTER PROGRAM.

An interesting program for the winter season has been outlined by the Sheffield branch of the British Foundrymen's Association. The papers and meeting dates are as follows:

Nov. 6—"The Scope of Science in the Foundry", by Richard Mather, Middlesbrough.

Nov. 20—"Modern Bronzes", by R. H. Greaves, Birmingham.

Dec. 11—"The Foundry and The Man", by W. H. Sherburn, Warrington.

Jan. 22—Lecture and demonstration, "The Heat Value of Fuels", by Frederick K. Knowles, Sheffield.

Feb. 19—"The Production of Malleable Cast Iron", by Joseph Matthews, Walsall.

March 26—"Some Mechanical Patterns in Repetition Work", by George Buchanan, Wrexham.

April 23—"Some Modern Foundry Appliances", by H. S. Green, London.

AN ALUMINUM FLUX.

Chloride of zinc is now extensively used as a flux in melting aluminum. It is thrown on the surface of the melted metal in the crucible, before pouring. The quantity to be used depends upon the amount of dross on the surface of the metal, which should be vigorously stirred throughout the reaction. If the surface of the metal has not been cleaned by the first lump of chloride of zinc, another small piece should be used.

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Test of Cast Iron

Several recent investigations, to determine the causes of the variations in the results of physical tests of cast iron, have added materially to the existing knowledge of this interesting subject. The series of experiments reported to the conference of the International Association for Testing Materials indicates that circular bars show greater bending and tensile strengths than those of rectangular section. Furthermore, test pieces taken from castings showed lower strength figures than bars separately cast. The object sought in making the tests was to ascertain what influence the slow cooling, to which castings may be subjected, exercises on the grain or the strength of the cast iron, and what part is played therein, by the different thicknesses of metal. Bars, plates and hollow castings were treated, which were permitted to cool in the molds. The plates cooled more slowly than the bar samples, and the material proved somewhat softer, giving smaller values for the bending, tensile and compressive strengths, but was better as regards flexure and strength to resist impact. These results were more pronounced in connection with the hollow castings, which naturally cooled more slowly than the plates. The grain, and with it the strength of the material, remained the same in the four walls of the castings, thus indicating uniform cooling throughout.

Another series of tests, reported to the Iron and Steel Institute, developed that—

The best tensile and transverse tests are obtained from bars which have been machined.

Transverse test bars cast on edge and tested with the "fin" in compression give the best results in testing.

The transverse test is not so reliable or helpful as that of the moment of resistance.

Cast iron gives the best results when poured as hot as possible.

The examination and study of a large number of test bars for castings used in the Baltimore sewage pumps, led another investigator to conclude "that the test bar is not to be regarded with too much confidence as indicative of the exact strength of the casting". It was also found that blow holes seem to be more frequent in flat transverse bars than in round, attached tensile bars, but the latter seem liable to a greater abnormal hardness, for which no explanation is offered.

The methods of determining the strength of cast iron to satisfy commercial specifications are by no means uniform, despite the recommendations of several technical societies, and the adoption of standard practice would correct many errors and would obviate many misunderstandings between the consumers and producers, which now frequently occur.

Trade Outlook

During the past 30 days heavy purchases of pig iron for future consumption have been made by both steel-producing and foundry interests, and further advances have been recorded on all grades. The continued improvement in the iron and steel trade is reflected in the foundry industry, the gray iron branch, which has been lagging behind, is more active, and the new tonnage offered is rapidly increasing. Some of the largest pig iron purchases of the month include 60,000 tons of gray forge by the United States Cast Iron Pipe & Foundry Co.; 30,000 tons of basic by the Scullin-Gallagher Iron & Steel Co., St. Louis, while an eastern steel casting plant has contracted for 18,000 tons of low phosphorus iron. Basic iron, owing to the heavy purchases of steel-making and foundry interests, has been advanced to a basis of $19.00, Philadelphia. Southern iron is still quoted at $14.50 Birmingham, although several large furnace interests are endeavoring to secure $15.00 for future delivery. Pig iron quotations in other centers follow: Basic, Pittsburg, $18.15 to $18.40; Bessemer, Pittsburg, $19.90; No. 2 foundry, Pittsburg, $17.90 to $18.50; gray forge, Pittsburg, $17.40 to $17.65; No. 2 foundry, Chicago, $19.00 to $19.50; Lake Superior charcoal, Chicago, $20.00 to $20.50; southern Ohio No. 2 foundry, Cincinnati, $18.20 to $18.70; No. 2 X, New York, $18.75 to $19.25; low phosphorus, eastern Pennsylvania, $22.50. Large orders for castings for cars continue to be placed with malleable and steel foundries, and a considerable tonnage is now under negotiation for the 40,000 freight cars that will shortly be placed. Brass founders are unable to cope with the demands of the automobile makers, and many new shops are being erected, especially in eastern Michigan where the motor car industry is flourishing. Despite the heavy consumption, non-ferrous metals are practically unchanged in price.

PERSONAL.

Amos S. Kirkpatrick, formerly foreman of the foundry operated by the Jones & Hopkins Mfg. Co., Nashville, Tenn., has been appointed superintendent of the plant of the Avondale Stove & Foundry Co., Birmingham, Ala.

Arthur S. Blanchard, formerly connected with the Atha Steel Casting Co., and the Wellman-Seaver-Morgan Co., is now associated with the Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa., in the capacity of assistant general manager.

Leo G. Smith, formerly superintendent of the Bucyrus Steel Casting Co., Bucyrus, O., has resigned to accept a similar position with the Londonderry Steel Foundry, Londonderry, N. S.

Thomas N. Burman is now associated with the Berkshire Mfg. Co., Cleveland, in the capacity of molding machine sales representative.

George H. Wadsworth, of the Falls Rivet & Machine Co., Cuyahoga Falls, O., manufacturer of core room equipment, recently returned from a two months' tour of England, Scotland, France and Germany.

F. H. Dodge, who has had a wide experience in the foundry trade, has been appointed sales representative of the S. Obermayer Co., Cincinnati, in Cleveland and the immediate vicinity.

R. A. Smart, formerly assistant manager of works of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has been appointed works manager of the Oliver Chilled Plow Co., South Bend, Ind.

Charles H. Speer, consulting engineer and a member of the firm of Carr & Speer, New York City, has accepted a position with the Algoma Steel Co., Ltd., Sault Ste. Marie, Ont., in the capacity of assistant engineer.

W. S. Giele, until recently superintendent of the plant of the Stoever Foundry & Mfg. Co., Myerstown, Pa., has severed his connection with that concern, and at the present time is engaged in special work.

AN UNUSUAL MELTING RECORD.

Low fuel consumption and melting loss are reported by a large concern, which conducted a test in a double-chamber melting furnace built by the Rockwell Furnace Co., 26 Cortlandt street, New York City. The results follow: Melted copper (ingot and scrap) 2,745½ pounds, scrap (miscellaneous) 5,981 pounds, lead 503½ pounds, tin 255 pounds, zinc 139 pounds. The metal charged amounted to 9,534 pounds, of which 9,274 pounds was recovered, the loss aggregating only 260 pounds, or 2.73 per cent. The oil consumed totalled 153.84 gallons, equal to 1.61 gallons per 100 pounds of metal melted.

L. A. CRANDALL.

L. A. Crandall, manager of the western branch of the J. W. Paxson Co., Toledo, died at his home in that city, Oct. 17, after a short illness. For nearly 25 years he was connected with the foundry supply and equipment trade in various capacities, and his acquaintance among foundrymen extended to every state in the union. To his knowledge of the foundry business and his ability to make and retain

L. A. CRANDALL

friends, his unusual success as a salesman was attributed.

Mr. Crandall was born Jan. 21, 1850, and served an apprenticeship as a machinery molder. Before entering the foundry supply trade he served as foreman and superintendent of a number of large foundries. For nine years he was in the employ of Byram & Co., Detroit, in the capacity of traveling salesman, and later he was similarly employed by two large foundry supply houses. About 11 years ago he designed the Crandall or bosh cupola, and many furnaces of this type have been installed throughout the country, while this bosh attachment has been placed on a number of other makes of cupolas. The Crandall cupola is now manufactured by the J. W. Paxson Co., Philadelphia, with which concern Mr. Crandall became associated less than a year ago. He was one of the organizers of the Detroit Foundry Supply Co., Detroit, in which he was largely interested, and served as vice president for several years.

INTERESTING HISTORY OF A PITTSBURG FIRM.

An interesting historical sketch of the development of the firm of Mackintosh, Hemphill & Co., Pittsburg, is presented in an elaborately illustrated catalog covering the broad scope of its line of manufacture of machinery for iron and steel works and allied industries, which has been issued by the company. This is as follows:

While the firm of Mackintosh, Hemphill & Co. has been the owner of the Fort Pitt Foundry since 1878, the establishment itself dates back to the early part of the last century, the guns for Perry's fleet in the war of 1812 having been cast there. In 1825, Alexander McClurg became the owner, the foundry then producing everything in the shape of cast iron from shot and cannon up, the engines for the Portage road having been built here, also the first locomotive west of the Allegheny mountains. Naturally, the plant at that time was only equipped with crude and primitive appliances, the cannon being bored and machined in lathes worked by horse power, but despite the great disadvantages under which it was necessary to work, the machinists of those days turned out work of remarkable accuracy.

The Fort Pitt foundry enjoys the distinction of being the oldest on the ground now covered by the city of Pittsburg, to survive on its original site. There were a few other foundries that antedated it, but all trace of the sites of their early establishments has been lost.

Alexander McClurg was succeeded as sole owner of the plant by the firm of McClurg, Pratt & Wade, about 1830. During the period intervening between that time and 1873, the personnel of the firm naturally changed several times. Fire wiped out the entire establishment in March, 1858, leaving no trace of the buildings. The machine shop was not rebuilt at that time, attention being confined to foundry work. The facilities of the plant were greatly increased at the outbreak of the Civil war in order to take care of the large demand for heavy ordnance.

In 1858, James Hemphill, Dr. W. S. Mackintosh and N. F. Hart organized the firm of Mackintosh, Hemphill & Co., and began business on an adjoining site. William Wade became interested in the company a few years later, and the firm, as thus constituted continued in business on the original site for 20 years. In 1878, Mackintosh, Hemphill & Co. acquired the Fort Pitt Foundry. James Hemphill proved one of the leading spirits in the advance of the steel industry, being considered one of its foremost authorities. It was to his initiative that the building up of this company was principally due.

Upon its acquisition by Mackintosh, Hemphill & Co., in 1878, the plant was completely remodeled, preserving nothing but the buildings, the latter being improved and additional new structures added.

FOUNDRY & PATTERN SHOP EQUIPMENT

Mechanical mixing, blending and proportioning of molding sand --- Roll-over molding machine --- Patternmakers' clamp --- McCormick continuous sand mixer --- Electrically-driven cupola blower

THE economies that can be effected by the mechanical preparation of molding sand are now being more generally appreciated by foundrymen in this country, and in every modern shop a mixing, tempering and screening plant is considered a necessary part of the equipment. The recovery of the burnt sand greatly reduces the amount of new sand required, and in many shops 50 per cent of the old sand is used in the mixtures. Furthermore, mechanically prepared sand insures better molds and reduces casting losses to the minimum.

A number of new machines for mixing, screening and blending molding sand have recently been added to the extensive line of equipment of this type built by the Standard Sand & Machine Co., Cleveland. Fig. 1 shows a mixing, screening and tempering machine adapted for handling molding, core and facing sands. It is made in three sizes for batch mixing with capacities of 5, 6 and 7 cubic feet respectively. For continuous mixing, a false bottom is attached underneath the reciprocating screen, and the discharge gate, instead of being in the center, is located at one end, while the paddles are arranged to mix and work the sand toward the discharge opening.

The Screen.

An eccentric action at the head of the mixer gives a reciprocating motion to the screen frame, which is inclined, thereby automatically discharging at the lower end all foreign particles and lumps in the sand. This reciprocating screen is removable and can be readily replaced by one of a larger or smaller mesh as desired. The sand, after passing through the screen, falls into the mixer, where it is thoroughly mixed by means of a number of paddles arranged in such a way that the sand is rubbed, agitated and cut over many times within a few minutes.

Tempering Device.

The steam or air spraying device is shown at the lower end of the mixer and is adjustable so that the operator can vary the tempering at any time. It is provided with special sprayers, which project the oil into the sand while the same is being mixed. These machines are, however, regularly equipped with a tempering device, consisting of a tank and spray pipe. When steam is used in connection with the oil spraying device, the oil is heated, thus making it possible to reduce the consumption of oil materially. In addition to the paddles, two sets of adjustable scrapers are provided that scrape the sand away from the shell, thereby keeping it clean and greatly reducing the wear on the paddles. This machine is also provided with drop sides, which are shown lowered in Fig. 1, to facilitate the cleaning of the machine.

Sand Proportioning and Conveying Plant.

A combination of this mixer and a sand proportioning and conveying plant recently installed in the Cleveland plant of the Aluminum Castings Co., formerly the Allyne Brass Foundry Co., is shown in Fig. 2. Two sand hoppers are provided, one for old sand and one for new, which discharge into a conveyor boot at the bottom of the pit. These hoppers automatically proportion the old and new sand, this being controlled by the sprocket wheels on the hopper shaft, and can be easily changed for the various proportions desired. A third hopper, located slightly above the two sand hoppers, is provided for a dry core compound, and the proportioning of this material can similarly be adjusted by changing the sprocket wheel

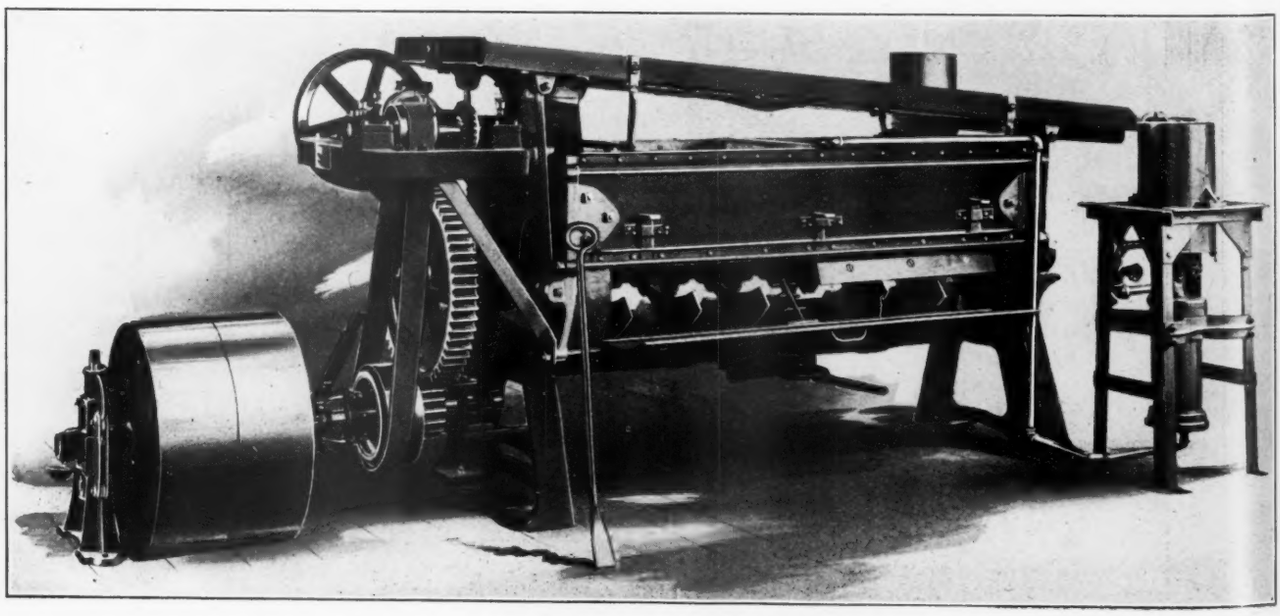


FIG. 1—SAND MIXING, SCREENING AND TEMPERING MACHINE

located on the side. This material is discharged into the elevator boot, and together with the sand is conveyed in buckets to the top of the machine where it is discharged into a pulverizer for breaking up lumps, etc. From this pulverizer the sand, already proportioned, together with the proper amount of core compound, is discharged onto the screen. This machine is motor driven.

Chain-Driven Mixer.

A small sand mixer equipped with a chain drive connected with a countershaft, which has a driving pulley and a sprocket clutch to throw the mixer in and out of gear, is shown in Fig. 3. The mixer has a capacity of about one wheelbarrow load and requires only a small amount of power. It can also be equipped with a tank and spray pipe for tempering, and is adapted for mixing core and facing sands.

Large Au omatic Sand Mixer.

A large machine for proportioning, screening, tempering, mixing, rolling, blending and crushing molding, core and facing sands, is shown in Fig. 4. It is provided with a three department feed hopper located in front of the machine for accurately proportioning the three materials that are to be mixed. The proportions can be changed by substituting augers of different sizes, or by changing the sprocket wheels on the hopper shafts. The three materials are delivered to the elevator boot located below and at one end of the three-department hopper. The materials are then elevated to the machine proper and are discharged on a reciprocating screen, which is inclined to carry off lumps, particles of iron, etc., and which are discharged through the spout shown at the end. From the screen the sand falls onto a curved plate, where it is mixed and tempered and conveyed to one end, where it is discharged through a spout into a revolving drum. This drum is provided with a series of steel buckets running throughout its entire length, which carry up and deposit upon the rolls, the material discharged into the drum. The drum is provided with two sets of rolls, 72 inches long, and for a distance of about 12 inches at each end they are corrugated to crush any lumps which may have passed through the screen. These rolls crush, roll and blend the material. During one revolution of the drum the material passes through the rolls twice, making a total of 24 rollings in passing through the drum. One roll of each set is fitted with springs, which permit the rolls to adjust themselves to the quantity of material passing through them. From the drum the material is discharged at a point underneath the machine, clearly illustrated in Fig. 4.

FIG. 3—SMALL SAND MIXER OPERATED BY CHAIN DRIVE

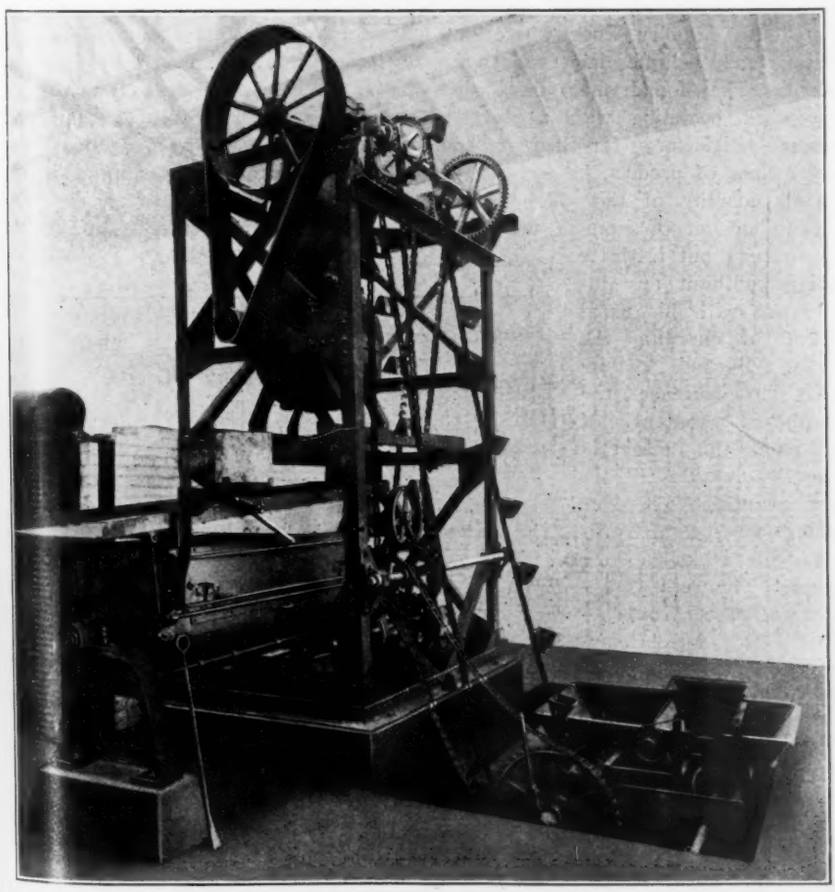


FIG. 2—COMBINATION SAND MIXING, PROPORTIONING AND CONVEYING PLANT

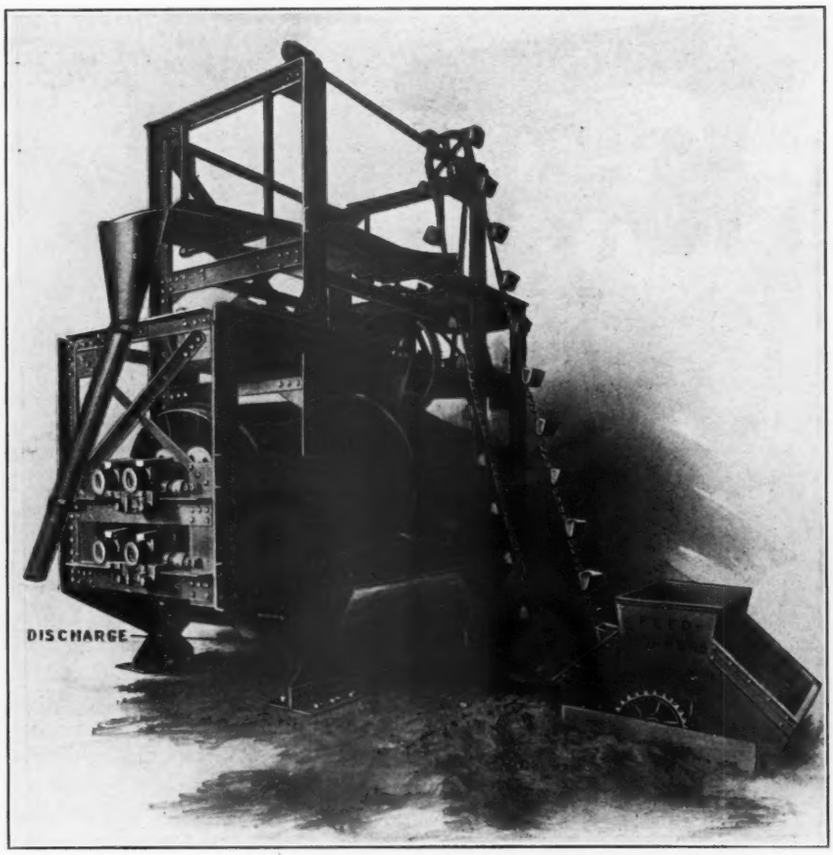


FIG. 4—AUTOMATIC MACHINE FOR PROPORTIONING, SCREENING, TEMPERING, MIXING, BLENDING AND CRUSHING MOLDING, CORE AND FACING SANDS

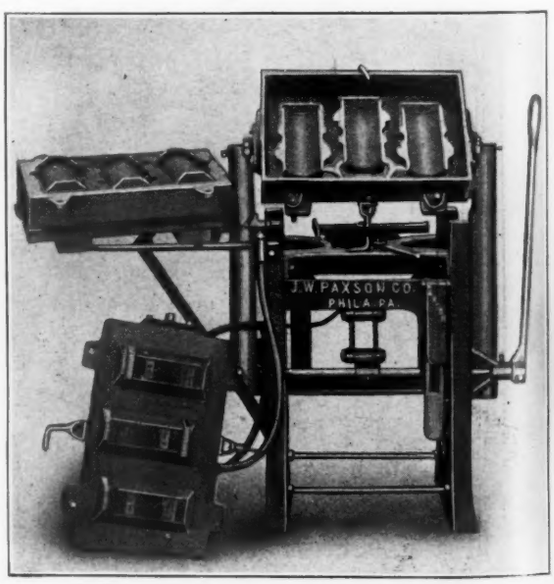
GROUND FERRO-PHOSPHORUS FOR FOUNDRY USE.

Experiments, which have been under way for some little time in connection with the use of ground ferro-phosphorus in the foundry have shown such successful results that one manufacturer of this alloy has established a mill for grinding it at the Rockdale furnace, Rockdale, Tenn. Only high grade ferro-phosphorus is put into the ground material, the phosphorus content running uniformly about 20 per cent. The crushing rolls are adjusted to one-eighth of an inch apart, and owing to its coarse crystalline nature, the material is all practically reduced to a powder, only a very small proportion remaining in the form of fine lumps. In the foundry ground ferro-phosphorus naturally finds its use in correcting the difficulties arising from the presence of too little phosphorus in the iron. Practically its principle advantage lies in the ability to widen the range of product possible without a change in the mixture employed. The usual practice is to deposit a small quantity of the powder in the bottom of a large mixing ladle, from 2 or 3 up to 15 pounds to a ton of iron. As the molten iron is tapped from the cupola, it immediately absorbs the alloy and, by virtue of this addition to its phosphorus content, becomes especially adapted for foundry work where thin castings and delicate impressions are desired. The foundryman finds that even when operating with a sluggish mixture satisfactory for heavier and coarser lines of product, by addition of a small quantity of this alloy to the requisite amount of iron in the ladle, he can turn out intricate castings without any interference with his usual method of charging the cupola. Because of its ability to increase the phosphorus content of any iron, this alloy is generally employed in small quantities wherever greater fluidity and reduced shrinkage are sought. The mill is located at the Rockdale furnace, Rockdale, Tenn., the product of which, both in lump and ground form, is sold by Hickman, Williams & Co., Chicago.

The Tropenas Steel Co., New Castle, Del., recently shipped the complete equipment of a two-ton Tropenas converter plant to the Cavite Navy Yard, P. I. One baby converter made by this concern is now being erected in the plant of the Michigan Crucible Steel Casting Co., Detroit, and another will be installed in the plant of the DeSoto Foundry & Machine Co., Mansfield, La. Tropenas converters are now being built, which will be carried in stock, and within the next few months this concern will be in condition to ship a complete plant within two days after the receipt of the order.

THE PAXSON ROLL-OVER MOLDING MACHINE.

The roll-over molding machine shown in the accompanying illustration, manufactured by the J. W. Paxson Co., Philadelphia, is especially adapted for brass foundry work. The same card of patterns used when molding on the bench can be used on the molding machine by merely screwing it to the pattern plate. Match plates can similarly be fastened to this pattern plate, and these can be used to advantage, as the machine has a draw of 11 inches. Either straight or bevelled iron flasks can be used, and after the pattern has been mounted on the pattern plate, the flask rammed, and the bottom board adjusted, the mold is held by clamps attached to the pattern plate, the hand lever is drawn forward until the mold has reached a sufficient height to permit it to be rolled over, after which it is lowered upon a tripod leveling device. After the bottom board has been leveled this device



THE PAXSON ROLL-OVER MOLDING MACHINE

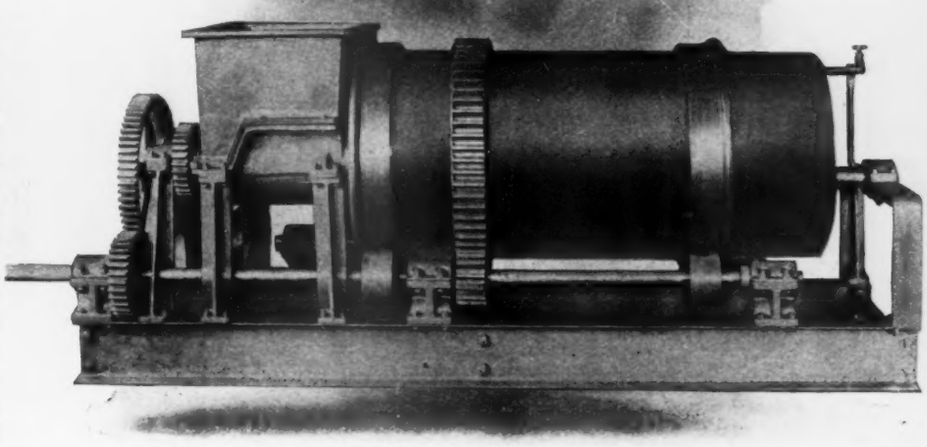
is locked, the clamps are removed and the pattern plate is moved upward, withdrawing the pattern from the mold, this operation being accomplished by the hand lever. The pattern plate is locked in position until the mold is rammed, after which the same operation is repeated.

THE TODD CLAMP.

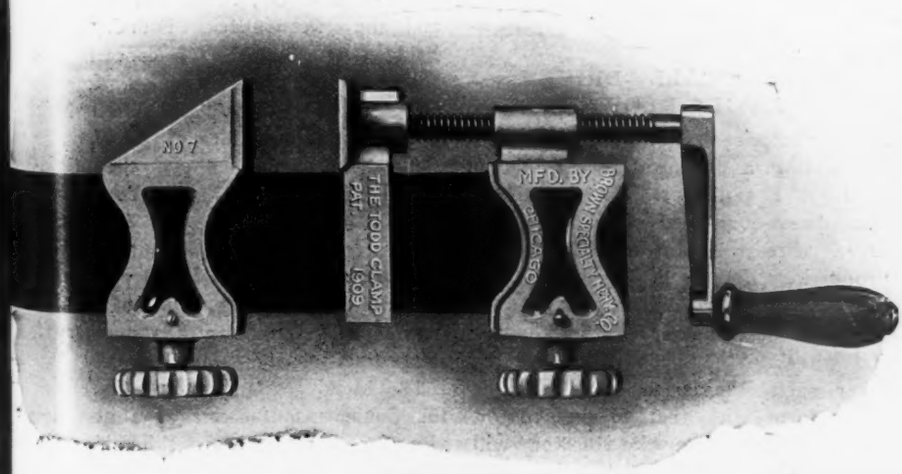
The Todd clamp, shown in the accompanying illustration, manufactured by the Brown Specialty Machinery Co., 73-75 West Jackson boulevard, Chicago, is made of malleable iron, 3-16-inch thick. It is designed to fit on a wood bar 1¼ x 3 inches, thereby eliminating the extra weight and spring of an iron bar, and permitting the use of the clamp for work of any size. The movable jaw is equipped with a hardened steel bushing against which the feed screw is centered, thereby directing the entire wear against this bushing instead of against the jaw itself. The end of the feed screw is also hardened. By replacing this bushing when worn, the life of the clamp can be materially increased. The feed screw is centered by a split washer which also holds the movable jaw rigid. Set screws are used for holding the bushing and washer in position. The rear stationary jaw has a bearing surface, 2 inches square, and both stationary jaws are provided with milled plates which firmly grip the bar when tightened by the hand wheel screws. The nut on the forward stationary jaw is 1¾ inches long, while the feed screw operating the movable jaw is 7½ inches long and is cut seven threads to the inch.

THE McCORMICK CONTINUOUS SAND MIXER.

The sand mixer shown in the accompanying illustration, built by the J. S. McCormick Co., Pittsburg, is so constructed that wear on the operating parts, as a result of the abrasive action of the sand, is reduced to the minimum. Sand is fed into a hopper containing two feed worms or screw conveyors, which deliver the material to a revolving drum, inside of which is a rotating reel operating in the same direction as the drum. This reel is so constructed that it thoroughly mixes and cuts the sand before it is discharged from the machine. At the discharge end of the drum is a device for tempering the material as it is being turned over. The machine can also be arranged as a proportion mixer by placing a partition in the hopper and operating the feed worm at different speeds by the use of sprocket wheels. In this way facing and core sand can be accurately mixed. The machine is built in sizes having capacities from 10 to 15 tons per hour.



THE McCORMICK CONTINUOUS SAND MIXER



THE TODD CLAMP

HINTS ON THE PREVENTION OF DEFECTS IN IRON CASTINGS.

BY F. MASCORD

It cannot be denied that too many defective castings are still produced, and many valuable castings become wasters, mainly because young molders have not given the question of defects the necessary study. Defects found in machined castings run up costs both in the foundry and machine shop, wasting time and materials. There will always be a certain percentage of defective castings made in the best organized shops, but the output may be improved, and the costs reduced, if the leading causes that produce defects are more carefully noted.

Practical Hints.

Here, then, are a few practical hints proved in large tool works, both in the foundry and machine shops from keen observation and tests. On machined castings, blow-holes probably take the lead in quantity. There are three distinct kinds; one type is produced by the gases in the iron; another is produced by the iron being overcharged with sulphur, but the third is far and away most found in machined castings from placing close-ground facing sand on the top or back parts of patterns. This prevents the free escape of air or gases. Use open clean sand on the parts that are to be machined

and use the vent wire freely. Most defects are found in top sections or on the back parts, and this fact proves that air and gases are the molders' greatest enemies.

Suggestion for the Molder.

Use sand, on parts to be machined, as dry as possible consistent with safety in ramming-up and drawing patterns. Do not sleek these parts with the trowels, because more risks are incurred. The water-brush, too, must be kept away from molds as much as possible, as the castings are chilled and may break or crack in the weakest parts, and the chilled edges run up costs in the machine shops. The runners should be placed where the iron has the easiest flow through the mold. This reduces the conflict between the air and the iron when in the mold. Risers should be placed in the strongest parts. Do not pour iron at too great a heat, or scabs and seams will often follow, and remember that when pouring castings to be machined the gases should escape from the iron while still in the ladles. If facing sand is weak in its proportion of sea coal, and very hot metal is used, defects and trouble will follow, generally scabs and seams. Seams are often caused by the mold not being quickly covered with iron, and therefore sufficient runners should be used in all cases. Many castings are lost by careless skimming, and when too soft an iron is used, boring or drilling often exposes shrinkage defects. Inferior brands of pig iron used for machined castings contribute largely to the scrap heap, and machine shop costs.

Machine Tool Castings.

Machine tool castings require special study because several operations are performed on them in the machine shop, and molders have to consider this fact when on that class of work. The question arises, will these castings, that look so clean and sound in the cleaning department, stand the tests of the planer, milling machine, boring mill, drills, etc.? Fewer risks are run on those castings merely requiring a coat of paint. There is little doubt that in many foundries the patternmakers could save many castings if they were to allow a little more clearance on the back parts of many patterns, where the parts are machined, as slides, saddles, aprons, cones, or on smaller patterns, as gear blanks, bushings, friction rings, hand wheels, etc. Fully 70 per cent of the defects are found on the back or top parts of castings where gases chiefly escape, so that the open, clean sand will assist them to get away freely. Avoid a crush by taking a trifle off the joint where most danger exists, as the dresser can easily remove this, and it has assisted the gases to escape. To give a good clean face to parts of castings not requiring machine operations, put as much new sand in the facing sand as possible, and not too much moisture. Use good quality of sea coal, and plumbago resists the iron better than charcoal and gives good, clean surfaces. Cover molds of light castings with hot metal as quickly as possible.

FIG. 1—STEEL PRESSURE BLOWER FOR DIRECT-CONNECTED MOTOR DRIVE

Be very careful as to the moisture of facing sand; use as little water as possible.

As regards cores, these will spoil castings if not properly dried and vented.

Use every care in preventing a crush or twist and see that molds are properly fastened or weighted before pouring the iron.

Do not allow air to escape through the runners when pouring or a scab will result.

Always keep runners full of iron when pouring the mold.

ELECTRICALLY-DRIVEN CUPOLA BLOWER.

The American Blower Co., Detroit, is building a pressure blower, shown in Figs. 1 and 2, which is designed for direct-connected electric motor drive. Pressure blowers of standard proportions operate at speeds too high to be electrically driven, but by increasing the diameter of the impeller and altering the proportions of the other parts, the speeds can be made to conform with that of any motor. At the same time the blower will produce any pressure and deliver any volume of air within the possibilities of accomplishment with centrifugal pressure blowers. The motor is attached by a flexible coupling, which avoids any difficulty from imperfect alignment by the use of four bearings in a row, two of which are on the motor and two on the blower. The blowers are of steel construction throughout, extremely narrow and rather high, and are provided with two winged struts attached to either side to give the necessary stability, thereby stiffening the casing and distributing the load over a greater area. These blowers will produce pressures up to 20 ounces per square inch, and as the strain on the bearings, due to the belt pull, is entirely eliminated, and owing to the slower speed, the tendency to heating of the bearings is materially reduced. These blowers are adapted for delivering air under any pressure to cupola, furnaces and forges.

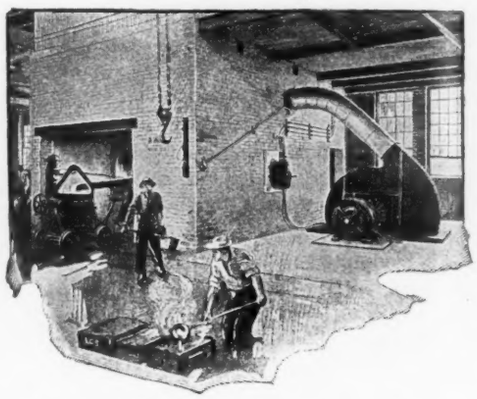


FIG. 2—STEEL PRESSURE BLOWER IN FOUNDRY, DIRECT-CONNECTED TO INDUCTION MOTOR

TRADE NOTES.

Wonham, Magor & Sanger, 30 Church street, New York City, designed and furnished the entire equipment for the new foundries recently built by Geo. H. Lincoln & Co., South Boston, Mass., and the Pequonnock Foundry Co., Bridgeport, Mass. This concern also recently sold the complete foundry equipment for the A. P. Smith Mfg. Co's. new plant at Newark, N. J.

Reactions, published by the Goldschidt Thermit Co., New York City, contains a number of very interesting articles on the uses of thermit including the welding of high pressure pipe lines, the welding of rails, marine repairs, as well as descriptions of a number of interesting jobs in railroad shops.

The Metal Dross Economy Co., Bristol, Conn., manufacturer of a new device for treating brass skimmings, is sending to the trade several circulars containing a description of this skim-

ming tank, and a number of complimentary testimonial letters are also reproduced.

"The Manual for Engineers", published by the University of Tennessee, Knoxville, Tenn., and compiled by Chas. E. Ferris, professor of mechanical engineering, contains considerable new data that has replaced some of the obsolete matter in previous editions. Some of the more important tables in the book include areas and circumferences of circles, squares and cube roots, sines, tangents and secants, both natural and common, steam tables for electric wiring, interest tables, etc. This publication is now in its 13th edition, is of vest pocket size, and is furnished at 50 cents per copy by the University of Tennessee Press, Knoxville, Tenn.

The September number of the *Obermayer Bulletin* contains the first of a series of articles entitled "Foundry Troubles—Their Remedy," by R. H. McDowell. The manufacture of sea-coal facing is also described and the use of perforated chaplets is outlined in a short article.

The H. E. Mills Mfg. Co., Syracuse, N. Y., is preparing plans for the erection of a plant at Solvay, N. Y., for the manufacture of core compounds.

The Hill Clutch Co., Cleveland, manufacturer of power transmission machinery, has appointed G. W. Hoffman sales manager in charge of its Chicago office, 610 Marquette building.

The S. Obermayer Co., Cincinnati, is now manufacturing a new core wash, known by the trade name of "Bull Dog." It is so called because of its great adhesive qualities, and it is claimed, in foundries where it is now in use, that no trouble is experienced by the core wash burning or peeling off.

The J. S. McCormick Co., Pittsburg, manufacturer of foundry supplies and equipment, has acquired the general foundry supply business of John A. Meighan, 1642 Second avenue, Pittsburg.

A circular issued by the New Era Mfg. Co., Kalamazoo, Mich., producer of special alloys and metals, contains a list of 100 brass foundry mixtures, including aluminum casting alloys, babbitt mixtures, brass, bronze and die casting alloys, as well as German silver. These formulas should prove of value to every brass foundryman in view of the fact that they include practically all of the commercial mixtures in use today.

Ewald Killing, proprietor of the E. Killing's Molding Machine Works, Davenport, Iowa, has been allowed a patent on the universal roll-over, straight drop molding machine, of which he is the inventor and manufacturer.

Nash, Isham & Co., 82 Beaver street, New York City, have been appointed exclusive eastern sales agents for the foundry iron produced at the Trussville, Ala., and Chattanooga, Tenn., furnaces of the Southern Iron & Steel Co., Birmingham, Ala.

The first of a series of artistic photographs directing attention to the merits of "Homogen", a powder which removes the natural and acquired impurities from metals having a copper base, is being sent to the foundry trade by the Allyne Brass Foundry Co., Cleveland.

TRADE PUBLICATIONS.

FUEL OIL AND GAS BURNING APPLIANCES.—The W. S. Rockwell Co., 50 Church street, New York City, is sending a pamphlet to the foundry trade, which illustrates a few of the latest types of Rockwell furnaces, fuel oil and gas burning appliances. A number of views of fuel oil and gas burners, as well as the Rockwell fuel oil pumping system are also included.

FUEL OIL BURNERS.—The application of fuel oil burners to foundry work is illustrated and described in an 8-page pamphlet issued by the Hauck Mfg. Co., 140 Cedar street, New York City. The portable burners made by this concern are used for lighting cupolas, drying ladles, repairing castings and skin drying and baking molds and cores. Special gas burners are also shown, which can be used for heating, tempering, annealing and melting furnaces, converters, core ovens, etc.

FANS, BLOWERS, ETC.—The B. F. Sturtevant Co., Hyde Park, Mass., has recently issued condensed catalog No. 165, which shows the complete line of fans, blowers, dust collecting and conveying systems, fuel economizers, engines, motors, turbines, etc., made by this concern. Principal dimensions and other useful information for the plant superintendent and engineer are included.

GAS ENGINES.—The Meriam vertical gas engine for electric lighting, pumping and general power purposes, built by The Bruce-Macbeth Engine Co., Cleveland, is described in a handsomely illustrated, 32-page catalog, recently issued.

PYROMETERS.—Bulletins Nos. 108 and 115, published by The Bristol Co., Waterbury, Conn., are devoted to the application of electric pyrometers in the heat treatment of steel. Bulletin No. 108 deals especially with the application of pyrometers for hardening and tempering furnaces, showing the type of instrument recommended, and the method of applying the form of thermo-couples most generally used in hardening furnaces. Bulletin No. 115 outlines the application of electric pyrometers to furnaces for annealing and case hardening.

LIFTING MAGNETS.—The diversified uses of lifting magnets are shown by numerous half-tone illustrations in a 62-page catalog recently issued by the Electric Controller & Mfg. Co., Cleveland. These magnets not only render efficient and economical service in the yards of steel plants for conveying material, loading charging buggies, handling scrap, etc., but can be used to advantage by foundries for handling castings, both in the shop and in the yard, unloading pig iron and scrap, as well as for handling skull crackers for breaking up material. A list of users is also included, which contains the names of most of the representative steel works, foundries, as well as structural steel fabricating plants in the United States.

SPEED REGULATORS.—The Cutler-Hammer Mfg. Co., Milwaukee, has issued a 16-page booklet describing its speed regulators for use with motor-driven boiler draft fans, feed pumps, gas pressure systems, etc. This device automatically regulates the speed of the motor to maintain the operating pressure practically constant.

OVERHEAD CARRYING DEVICES.—The New Jersey Foundry & Machine Co., 90 West street, New York City, in catalog 77, containing 96 pages, illustrates and describes its line of overhead trolleys, tracks, as well as hoists, cranes, buckets, cars and other accessories. The wide application of overhead trolley systems is shown by numerous illustrations, and in addition this concern manufactures a complete line of cars of every description, turn-tables, industrial railway switches, etc.

FOUNDRY CONSTRUCTION. — Wonham, Magor & Sanger, New York City, foundry engineers and contractors, have issued an 18-page booklet containing views of some of the numerous casting plants which they have recently designed and erected. A list of foundries recently built, modernized and those in which new installations have been made are also included.

FORGING, HEATING AND WELDING FURNACES.—The Rockwell Furnace Co., 26 Cortlandt street, New York City, in a 40-page catalog recently issued, illustrates and describes its line of forgings, heating and welding furnaces. Practically all of the illustrations show these furnaces in use in various plants. Portable heaters, which are not only adapted for work which is too large to be carried to a furnace, and for making repairs on boilers, steel cars, ships, etc., as well as for skin drying molds, drying cores, etc. in foundries are also illustrated. Several pages are also devoted to a description of the oil and gas burners made by this concern.

FANS AND BLOWERS.—The American Blower Co., Detroit, in a 46-page booklet, envelope size, briefly describes its line of vertical engines, mechanical draft apparatus for steam boilers, portable electric ventilating fans, the "American-Sirocco" propeller, blowers, exhausters, etc. Views of numerous installations are also included, and a number of valuable tables are given. This booklet is being translated in Spanish and Portuguese for Latin-American circulation.

GENERAL INDUSTRIAL NOTES

The Central Machine & Foundry Co., Marion, Ind., has been organized with $25,000 capital. The directors are Charles C. Chamberlin, Henry L. Erlewine and A. E. Loucks.

The Malleable Iron Works, Amherst, N. S., which suspended operations about 18 months ago, has been taken over by the Rhodes-Curry Co., and will immediately be placed in operation.

The plant of the Canada Brass Foundry Co., Toronto, which has been idle for several years, has again been placed in operation and will be known as the Ontario Brass Co.

The General Brass & Tool Works, Nashville, Tenn., recently organized, is now in the market for brass furnaces and light machine tools.

The Lawrence Iron & Steel Foundry Co., a Pennsylvania corporation, has succeeded the Yagle Foundry & Machine Co., Ltd., Pittsburg. This concern is now installing an open-hearth furnace and will soon have in operation a department for the manufacture of open-hearth steel castings.

The Wheeling Enameled Iron Co., Elm Grove, W. Va., has awarded contracts for remodeling its plant. The roof of the foundry, 70 x 200 feet, will be raised and runways installed for electric traveling cranes. Two 5-ton cranes have been purchased and the foundry will also be equipped with a complete sand handling plant.

The new foundry of the Peck Williamson Heating & Ventilating Co., recently removed from Wellston, O., to Cincinnati, is now in operation.

The Stoddard Union Co. has been incorporated with $25,000 capital to operate a foundry and machine shop. The company's address is Box 3283, Boston. The works will be located at Hills Grove, R. I. W. H. Stoddard is president and F. A. Stoddard, secretary.

The W. A. Eckert Mfg. Co., Buffalo, has been organized to take over the plant and patents of W. A. Eckert, who has been established in Buffalo for 15 years. This concern manufactures specialties of aluminum, brass and copper. The officers of the company are W. E. Eckert, president and general manager; F. G. Eckert, vice president, and E. L. Eckert, secretary and treasurer.

The Gem Brass & Mfg. Co., Des Moines, Ia., has equipped a plant for the manufacture of brass castings at 119 Walnut street, where the Criterion Motor Car Co. was formerly located.

The plant of the Buckeye Brass Foundry Co., Cleveland, has been sold to the United States Pattern Co., and hereafter the two concerns will operate under the name of the Buckeye Brass Foundry & Pattern Co.

The Russel Wheel & Foundry Co., Detroit, has purchased the plant of the A. P. Wagner Tool Works, and the buildings will be remodeled and machinery installed for the manufacture of automobile parts.

J. G. Coleman, president, and F. L. Coleman, secretary, of the Waukesha Malleable Iron Co., Waukesha, Wis., have disposed of their interest in that concern. The newly elected officers are C. A. Haertel, president; E. R. Estberg, vice president; J. J. Enders, secretary and J. H. Haertel, superintendent.

The Toledo Steel Casting Co. will succeed the C. E. Sutton Co. of that city, and the plant will be considerably enlarged. F. F. Meek, formerly sales manager of the Detroit Steel Casting Co., Detroit, is manager of the new concern.

The Bolivar Foundry & Machine Co., Bolivar, Pa., is erecting a new foundry, 43 x 100 feet. The engine room is 20 x 50 feet, cupola room, 20 x 30 feet, and core department, 20 x 20 feet. The buildings will be of brick and steel construction, and will be equipped with a 10-ton cupola and a 10-ton traveling crane.

The Inland Steel Casting Co., Terre Haute, Ind., has just completed the erection of a new foundry, the main building of which is 300 feet long and 75 feet wide. The core shop is 65 feet long and 35 feet wide, while the pattern shop is 75 x 45 feet.

The Garwood Bros. Co., North Manchester, Ind., has been incorporated with $25,000 capital to engage in the foundry trade. A. R., B. V. and J. A. Garwood are the incorporators.

New Construction.

The Atlas Brass Foundry Co., Columbus, O., will erect a two-story brick addition to its plant.

The Superior Bronze Co., 4044 Liberty avenue, Pittsburg, will extend its brass foundry by the erection of a building, 100 x 20 feet, which will be used exclusively for casting hot and cold roll bearings.

The Burlington Brass Works, Burlington, Wis., will erect an addition to its plant, 75 x 150 feet.

The Standard Sanitary Mfg. Co., Pittsburg, will build a Canadian branch manufacturing plant at Toronto, Can., at a cost of approximately $1,000,000. Electric power will be secured from Niagara Falls, but an emergency steam power plant will also be provided.

The American Locomotive Co. will build a three-story pattern shop and pattern storage building at Dunkirk, N. Y.

Wm. Shimer, Son & Co., Freemansburg, Pa., are erecting an addition to their foundry, 75 x 100 feet.

The Duquesne Steel Foundry Co., Pittsburg, whose plant is located at Coraopolis, Pa., is increasing its melting equipment by the installation of a 10-ton open-hearth furnace. This concern now has two 25-ton open-hearth furnaces and two 2-ton Tropenas converters in operation.

The North American Boiler Co. will erect a foundry at Muskegon, Mich. The equipment has not yet been purchased.

The Hamilton Foundry Co., Hamilton, Ont., is erecting a new plant, 57 x 82 feet, which will be equipped with a cupola of 6 tons capacity.

The Merrill Iron works, Merrill, Wis., has completed plans for a new foundry of concrete construction, which will be 60 x 40 feet. A cupola, crane and core oven will be installed.

The Albion Malleable Iron Co., Albion, Mich., is erecting a new pattern shop, 50 x 200 feet.

The Toledo Steel Casting Co., Toledo, O., recently organized, and which succeeded to the business of the C. E. Sutton Co., contemplates the erection of an addition, 69 x 240 feet, with a lean-to 50 feet wide extending the full length of the building.

The Dain Mfg. Co., Ltd., Ottumwa, Ia., will erect a new plant at Welland, Ont., for the manufacture of agricultural implements. The new plant will contain practically 60,000 square feet of floor space, one-third of which will be utilized for foundry purposes. Gray iron and brass castings will be produced.

The American Ornamental Iron & Bronze Co., Minneapolis, is erecting a new foundry, 39 x 72 feet.

The Tichener-Culver Iron Co., Binghamton, N. Y., will erect a new foundry of concrete construction to take the place of the plant destroyed by fire in May. The only equipment required will include a cupola and crane.

The Riverview Brass & Mfg. Co., Buffalo, will build a foundry, 50 x 96 feet, and a two-story finishing shop, 50 x 60 feet. The plant will be equipped for the manufacture of aluminum and brass castings.

The E. J. Manville Machine Co., Waterbury, Conn., is erecting a one-story pattern storage building, 46 x 80 feet.

The Manufacturers' Foundry Co., Waterbury, Conn., producer of gray iron castings, will erect a core shop, 50 x 103 feet.

The United States Brake Shoe Co., with plants at Walton, N. Y., Pittsburg and Corry, Pa., will erect a new foundry at the latter place, the main building of which will be of concrete and steel construction, 80 x 200 feet. Two cupolas will be installed, as well as a 10-ton electric traveling crane. The power house will be 30 x 45 feet.

The Lumen Bearing Co., Buffalo, is building an extensive addition to its plant.

The Detroit Valve & Fitting Co., Detroit, is completing plans for the erection and equipment of a plant at Wyandotte, Mich., for the manufacture of brass, malleable and cast iron fittings.

The Thiry & Kendrick Mfg. Co., Detroit, will erect a foundry building, 105 x 200 feet, at 660 Franklin street.

The Buhl Malleable Co., Detroit, will erect an addition to its foundry, 62 x 282 feet.

The Ferro Machine & Foundry Co., Cleveland, is erecting a new core shop, 70 x 120 feet, three stories high of brick and steel construction. The coremakers will occupy the top floor where one large core oven will be located. The second floor will be used for pasters and assemblers, and the supplies will be kept on the first floor. The entire contract for the installation of the equipment has been placed with the J. D. Smith Foundry Supply Co., Cleveland.

Joseph Sawyer, Oswego, N. Y., whose foundry was recently destroyed by fire, is now having plans prepared for a new plant which will be located on the site of the old building.

The American Motor Castings Co., Detroit, will erect a new plant at Marston court and Morrow street. The foundry will be 133 x 220 feet, and the machine shop, 87 x 261 feet.

The Fremont Foundry & Machine Co., Fremont, Neb., is erecting an addition to its foundry which will double its capacity.

The Reading Steel Casting Co., Reading, Pa., will erect an addition to its foundry, 80 x 40 feet.

Ground has been broken for an addition to the plant of the Belle City Malleable Iron Co., Racine, Wis., which will be 82 x 350 feet and three stories high. It will contain a machine shop, annealing room, pattern shop, shipping department and offices. The power plant equipment to be installed includes a 300-horsepower engine and a 200-kilowatt generator.

The Indiana Radiator Co., Walkertown, Ind., will erect a foundry for the manufacture of radiators and sash weights. The company is capitalized at $30,000.

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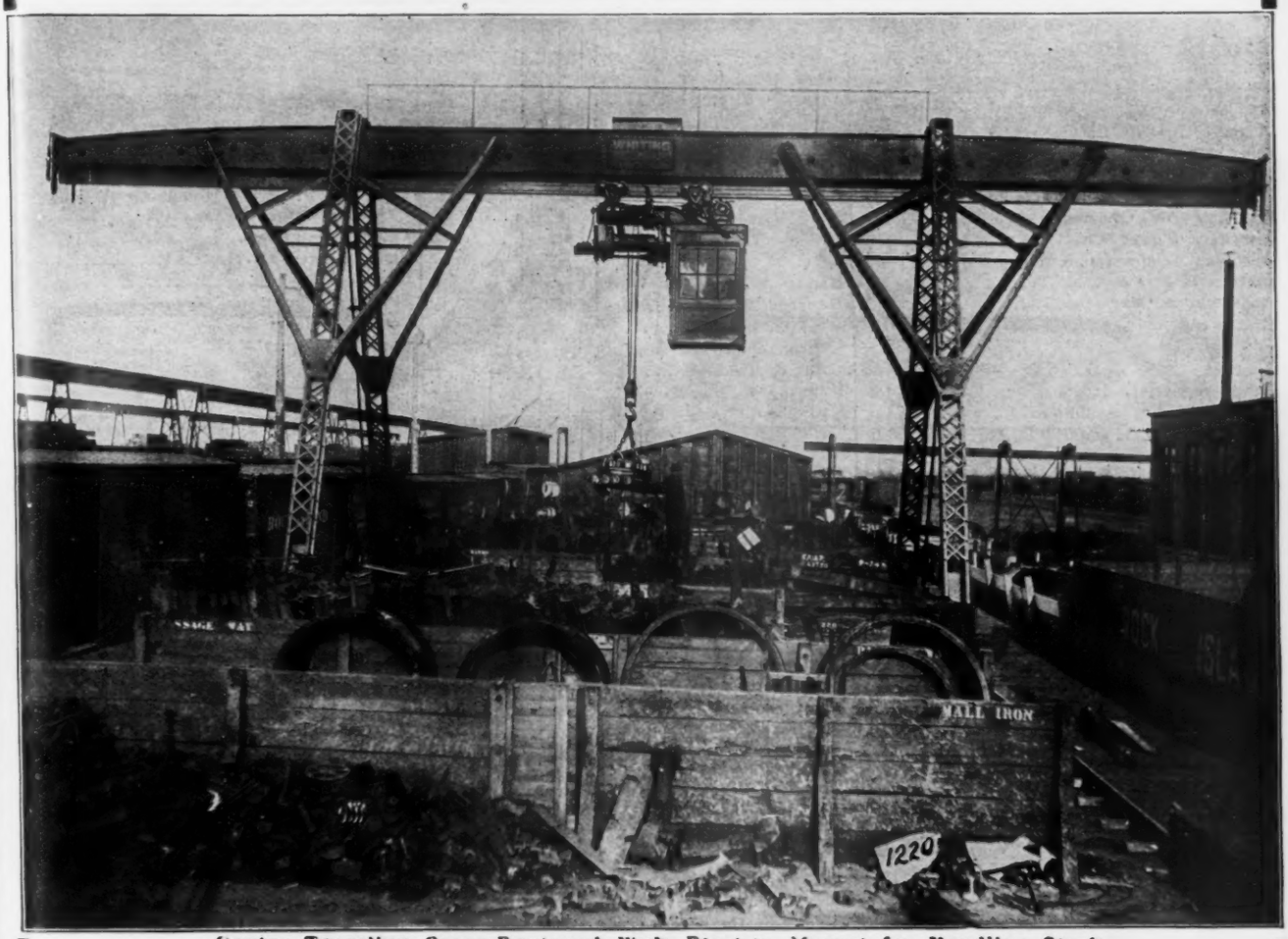

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